SCIENTIFIC AMERICAN SUPPLEMENT No. 282

Scientific American Supplement, Vol. XI., No. 282.
Scientific American, established 1845.

NEW YORK, MAY 28, 1881.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

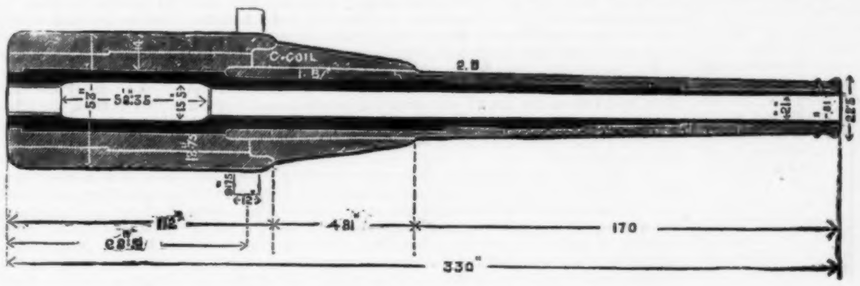
NEW 43-TON BREECH-LOADING GUN.

In the engraving we give the principal dimensions of the new 43-ton breech-loading gun tried at Shoeburyness on the 16th of March. The Shoeburyness trial related to accuracy at comparatively short ranges over water, the long ranges over the sands not being available just now, owing to a legal question which has been raised with regard to a certain portion of them. Accuracy can, however, be tested at targets firing over water. This is especially desirable on account of the form of rifling under trial. The form of groove is peculiar, being much eased away from the driving edge to obtain contact as far as possible in that part where it is not secured by the pressure due to driving. We mentioned, says the *Engineer*, the fact that with a projectile weighing 703 lb., and a charge of 300 lb., a velocity of 1,930 feet had been obtained. The charge of 285 lb., with a projectile 714 lb. weight supplied to Shoeburyness, of course entails a rather lower velocity.

The breech loading fittings are not shown in section; they are of the same form as those of the smaller breech-loaders recently made in the gun factories, except that mechanical power is employed for moving the breech-piece. A winch is applied to a quick-pitched screw to draw back the breech-piece, a slow screw being provided for use if necessary to start the movement after firing. The locking lever is moved through the necessary angle by the application of the same winch handle to a train of three pinions working on a toothed arc fixed on the breech end of the gun.

The gun is now mounted on a carriage with a peculiar form of yoke, suggested by the Engineer Department with a view to holding the slide down, taking the place of a pivot. There is an alternative method, we believe, designed to meet the same end. This matter, indeed, is as yet in a very imperfect state of development. As regards power, as we have before remarked, this gun is very successful. The stored-up work with the shot and velocity above mentioned, is about 18,170 foot-tons, the penetration being equivalent to a plate of somewhere about 23 inches thick.

When the 43-ton B. L. gun was fired at Shoeburyness on March 16, a velocity of 1,850 feet was obtained, accompanied by a pressure of only 17·3 tons. The actual charge was 286 lb., the chamber being found to hold one more pound than was reckoned on. The yoke employed to replace the front pivot acted very well.



NEW 43 TON BREECH-LOADER.

A Large Crank Shaft.—The crank and crank shaft of the City of Rome, the new Inman liner, are approaching completion at Messrs. Whitworth's. The crank has three throws, each piece weighing about 20 tons, and the whole about 61 tons, while the shaft of fluid compressed steel forged hollow will weigh 18½ tons when finished.

THE PANAMA SHIP CANAL.

We give a plan of the Panama Ship Canal, and sections of various types. The total length of the canal will be about 46 miles, including the jetties at Panama and at Limon Bay on the Pacific side. The plan, which we take from *Engineering*, shows clearly the trace of the canal and its relation to the River Chagres and the railway, which appears to cross the canal twice, near Pedro Miguel at the fifth station, and again at Baila Monos near the third station. From Cruces the canal and the River Chagres cross and recross each other frequently, and the latter will practically disappear and be replaced by the new channel. There will be five stations or pausing places as follows:

Station.	Approximate Distance from Colon.	Length.	Width.	Location.
	Miles.	Feet.	Feet.	
No. 1 ..	4¼	1,640	236	Gatun.
No. 2 ..	9	1,640	236	Pena Blanca.
No. 3 ..	20	3,280	236	San Pablo.
No. 4 ..	28	3,280	223	Matachin.
No. 5 ..	40	1,640	223	Pedro Miguel.

The width of the last two stations is reduced, because they will be made in rock. The depth of them will be twenty-nine feet six inches, and of the others twenty-seven feet nine inches. The plan also shows the position of the great barrage at the outlet of the lake, the water from which will be used in working the compressors for driving the rock drills and other machinery. As will be seen from this section, the canal will, up to about the twenty-eighth mile, run through soft ground, and from that distance to the fifth station it will have to be cut through rock, the highest point of which occurs at Cerro Culebra; after passing station No. 5, the rest of the canal runs through soft ground. The various sections indicate the form of the canal at different points. Fig. 3 is a type section in soft ground, where the width at the water level is one hundred and sixty-four feet six inches, and at the bottom one hundred and five feet, the depth being twenty-six feet three inches. Fig. 4 is a section in similar ground of the station, the dimensions being those given above. Fig. 4 is a section through rock and cutting, where the width will be ninety-one feet ten inches at the water level, and seventy-eight feet nine inches at the bottom, the depth being twenty-nine feet six inches. Fig. 6 is a corresponding section in rock, and Fig. 7 is a section of the sea channel, where the width of bed is three hundred and twenty-eight feet, and the depth about thirty-one feet. The following table gives a summary of the excavation that will be required in completing the work:

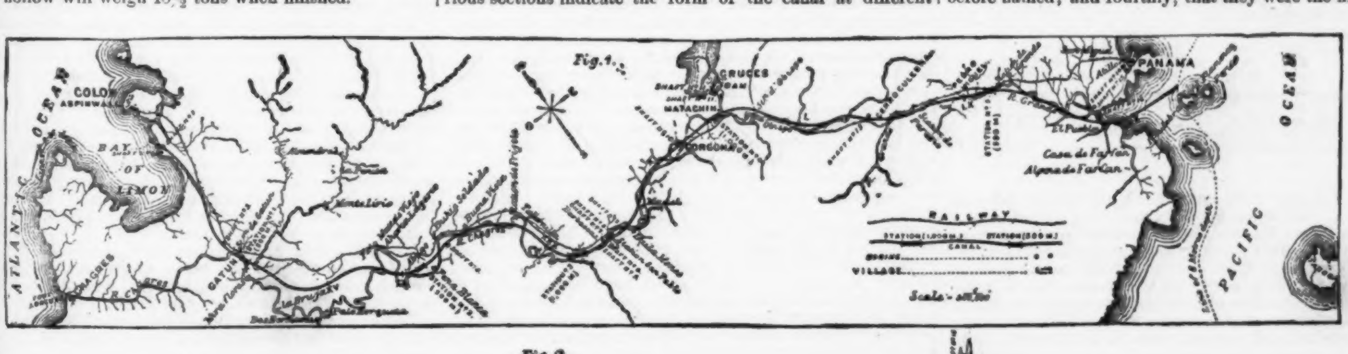
Nature of Material.	Cube Yards.
1. *Above Water Level:*	
Earth	34,707,000
Soft rock	650,000
Hard rock	27,411,000
2. *Below Water Level:*	
Sand and soft ground	22,740,000
Rock dredging	1,284,000
Hard rock	10,521,000
	97,813,000

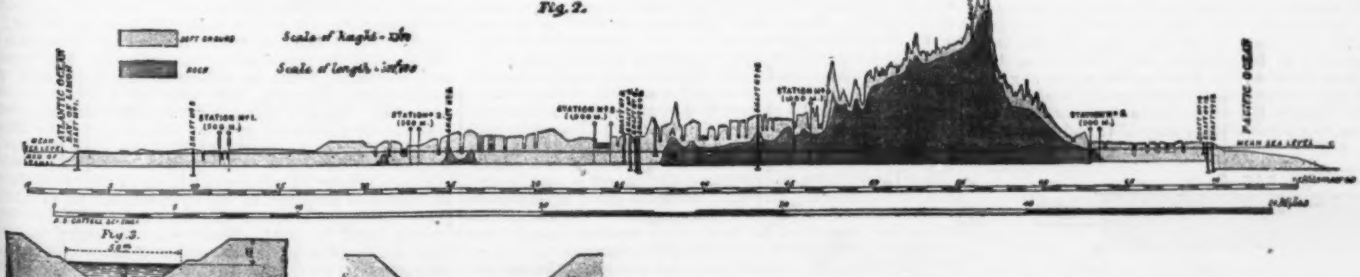
THE OTTO GAS ENGINE.

OTTO v. LINFORD

In the High Court of Justice, Chancery Division, before Vice Chancellor Sir James Bacon, March 23 80 1881, this action was commenced on the 26th July, 1880, by Mr. Nicolaus August Otto to restrain alleged infringements by the defendants, Messrs. Charles Linford & Company, of Leicester, of letters patent dated the 17th May, 1876, No. 2081, and granted to Mr. C. D. Abel, the agent of the plaintiff. The defendants, besides denying that they had infringed, gave notice by their particulars of objections, that they disputed the validity of the plaintiff's patent on the following, among other grounds, namely, that the first and second claims in the plaintiff's specifications were claims for a principle, and that the mechanical appliances for carrying the principle into effect were not particularly described in the specification; that the invention had been anticipated by the following prior letters patent, viz.: J. H. Johnson, 14th January, 1861, No. 107, and 8th February, 1860, No. 335; G. B. Babacci, 29th April, 1868, No. 1393; E. P. Alexander, 15th December, 1875, No. 434; C. D. Abel, 12th February, 1866, No. 434; Barsanti and Martteiuci, 12th June, 1857, No. 1655; R. Gottheil, 2d January, 1874, No. 25; W. Barnett, 1838, No. 7615; M. P. W. Boulton, 10th March, 1866, No. 7381, and 8th July, 1867, No. 2000, and 19th June, 1868, No. 1988.

The plaintiff's case shortly was, first, that they were the first to introduce a cushion of non-combustible gas between the piston and the explosive; secondly, that they were the first to draw in behind a piston first air, and then air and gas mixed; thirdly, that they were the first to utilize the heat generated by the explosion in expanding the cushion of air before named; and fourthly, that they were the first to com-





THE PANAMA SHIP CANAL.

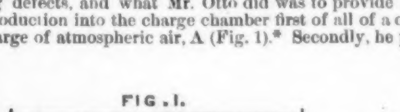
press a charge by the working piston in the working cylinder, and so render possible the combustion of comparatively dilute mixtures of gas and air.

The plaintiff administered interrogatories to the defendant, Linford, who stated by his answer that it was not correct to say that in the gas motor made by him a charge of combustible and incombustible fluid was compressed by one instroke of the piston or otherwise, or that any such charge of combustible and incombustible fluid had been drawn into the cylinder by the previous outstroke of the piston or otherwise. It was the fact that in his engines the compressed charge, when ignited, propelled the piston during the next outstroke, and that the products of combustion were partly expelled from the cylinder by the next instroke. He admitted that his motor performed all the operations and effected all the purposes mentioned in the second claim of the plaintiff's specification, except as regarded the action of the slide, which in the plaintiff's patent admitted air alone during the first portion of the piston's stroke, and air and gas during the remaining portion, whereas in Linford's engine the slide valve only admitted a combustible charge of air and gas during the whole of such stroke. In such motors the piston was propelled by the explosion of the charge, and the products of combustion were expelled from the cylinder partly by the next instroke of the piston. A scavenger charge of air was afterwards drawn in to expel the remaining products of combustion. He referred to the specification of his patent of 24th January, 1880, No. 330, for a description of the manner in which his engine was constructed and worked.

Mr. Aston, Q.C., Mr. Hemming, Q.C., and Mr. Lawson, were counsel for the plaintiff; and Mr. Kay, Q.C., Mr. Brett, and Mr. H. H. Cunningham were for the defendant.

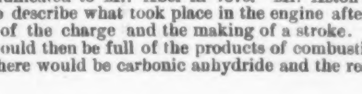
Mr. Aston, Q.C., in opening the plaintiff's case, stated that although the gas motor engine was not a new thing at the date of the plaintiff's patent, yet the invention of the plaintiff enabled a very new engine to be employed much more generally and successfully than such machines ever were before. Mr. Aston then proceeded to explain at some length the principle of the first gas engine, in which a mixture of gas and air was exploded behind a piston in a cylinder. It was necessary to have a mixture of ordinary atmospheric air, so as to cause the gas, the carbureted hydrogen, to explode, by giving the particles of oxygen and hydrogen sufficient oxygen for them to form an explosive mixture. The proportions might be three to one of carbureted hydrogen, to six or seven or eight or ten of atmospheric air. If, into the charge chamber of an ordinary cylinder working an ordinary piston, there were introduced a combustible mixture consisting of eight parts atmospheric air and one of carbureted hydrogen, and if this charge were ignited by a small flame outside, an explosion would ensue which would drive the piston violently back from one end of the cylinder. If we had a similar chamber at the other end of the cylinder, we might repeat the process there, and drive the piston back again, and that would be the best form of an ordinary gas engine. Again, instead of using a second charge to blow the piston back, we might trust to the gradual cooling down of the remains of the exploded charge, when a partial vacuum would be made and the piston released, and this had also been done; and these were the only two systems in use at the time when the Otto engine was invented. The defects of the existing gas engines were that the explosion produced a violent shock, almost sufficient to dislocate the strongest engine, and so much heat was generated and wasted in order to keep the cylinder cool as practically to nullify the advantages to be derived from the use of gas. Mr. Aston next proceeded to consider the advantages of gas engines, such as that they could be put down anywhere, and wasted no fuel when they were not at work, etc. Several attempts were made to get rid of the defects of the gas engine by Lenoir, Hugon, Boulton, and others, but unsuccessfully until 1876. He then went on to speak of Mr. Otto's earlier efforts to produce a good gas engine, and of his good fortune in meeting with Messrs. Crossley, of Manchester. He then proceeded to say that in 1876, or some time previous to that period, it occurred to Mr. Otto that if instead of causing a charge of the combustible fluid only, to explode in the gas chamber of a cylinder, he could introduce between the explosive mixture and the surface of the piston something that would act as a cushion and take off the shock, something that would also utilize the heat generated instead of wasting it, he could very easily, and by a very simple remedy, obviate the previously existing defects, and what Mr. Otto did was to provide for the introduction into the charge chamber first of all of a certain charge of atmospheric air, A (Fig. 1).* Secondly, he put

FIG. 1.



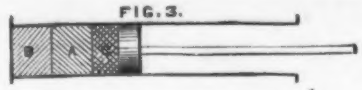
behind that a charge of the combustible mixture of gas and air, B (Fig. 1), and then by communicating as before the light of a gas jet to the combustible mixture he would allow the mixture to be fired, causing the heat generated to be absorbed in a very large degree by the cushion of atmospheric air, among which the particles of the combustible mixture would insinuate and disseminate themselves, and the operation instead of being sudden so as to cause violent shocks would be gradual, and economy would be effected by the cushion of air absorbing the heat, and expanding and doing work. This, in its simple form, may be said to be a description of the important steps in advance made by Mr. Otto, and communicated to Mr. Abel in 1876. Mr. Aston then went on to describe what took place in the engine after the explosion of the charge and the making of a stroke. The cylinder would then be full of the products of combustion—Fig. 2. There would be carbonic anhydride and the residue

FIG. 2.



of unconsumed atmospheric air. By the action of the fly-wheel the piston would be brought back again, and as it came back it would expel a certain portion of the products of combustion. When, by the continued revolution of the fly-wheel, the piston was again moved away from the closed end of the cylinder, the residue was carried back as room was left for it, and communication was opened to a supply, as provided by the patentee, of, first, atmospheric air, and then, behind, that combustible mixture; but the patentee provided for their being introduced in such proportions, and there was so much time given during the operation of the stroke of the piston, that instead of the three layers remaining divided and separate—as in Fig. 3—where A is air, B

FIG. 3.



combustible mixture, and C residual products of combustion—they became mixed together. The air and the residue of the charge commingled, the combustible mixture which was introduced last did the same, and the particles of the combustible mixture were dispersed through the entire charge; but they lay relatively more isolated, more dispersed, and more disseminated at the end next to the piston, less isolated, less dispersed, and less disseminated at the end next the point of ignition. By the action of the fly-wheel the piston now returned and compressed the charge, and in that compressed state it was fired, and in that compressed state the same relative conditions of mixture remained unaltered, and as the combustible mixture had its particles nearest together close to the point of ignition, there was gradual combustion and development of heat and of force. Such, Mr. Aston explained, was the general principle of the action of the plaintiff's engine, but before going further he thought it would be well to say that the method of dealing with and introducing a charge, and of allowing that charge to be compressed, was one that had been proposed to be used in some specification prior to 1876; but, as far as was known, no gas engine was ever made and used which worked upon that principle.

Mr. Aston than read the specification of the plaintiff, commenting on it as he went. The first portion of the specification, apart from the drawings, we print, because on it turned a large part of the case. The drawings round which most interest concentrated, we give in full size from the specification further on.

"In gas motor engines as at present constructed an explosive mixture of combustible gas and air is introduced into the engine cylinder where it is ignited, resulting in a sudden expansion of the gases and development of heat, a great portion of which is lost by absorption unless special provisions are made for allowing the gases to expand very rapidly. According to the present invention combustible mixture of gas or vapor and air is introduced into the cylinder together with air or other gas that may or may not support combustion in such a manner that the particles of the combustible mixture are more or less dispersed in an isolated condition in the air or other gas, so that on ignition, instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another, thereby effecting a gradual development of heat and a corresponding gradual expansion of the gases, which will enable the motive power so produced to be utilized in the most effective manner.

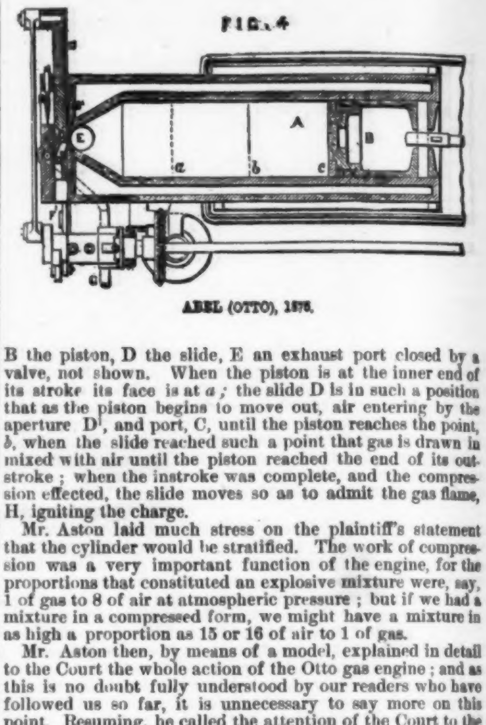
"The mode of using the gases and the arrangement of the engine may be variously modified in carrying out this invention. Thus, according to one arrangement the gases are introduced into the engine cylinder at atmospheric pressure. The cylinder is for this purpose provided with a slide having suitable ports for the admission of air and of an intimate mixture of combustible gas or vapor and air, and the movement of the slide is so regulated by means of a cam or eccentric on the engine shaft that during the first part of the stroke of the piston air alone enters the cylinder, while during a succeeding portion of the stroke the mixture of gas or petroleum vapor and air is introduced behind the air. This mixture in entering the cylinder will become more or less dispersed in the air previously introduced, the particles of the mixture being situated nearest together at the point where they enter the cylinder, and becoming gradually more dispersed as they mix with the air in front. A communication being now established by the slide between a small external gas flame and the contents of the cylinder at the point where the combustible mixture is most dense, this ignites, and the combustion of the whole charge takes place gradually, the mixture burning with gradually decreasing rapidity as the flame extends to those particles that are more dispersed among the air. The gradual expansion of the gases thus produced causes the piston to complete its stroke, and on the return stroke, which may be effected either by the momentum of the fly-wheel or by the introduction of a similar charge at the other end of the cylinder, the products of combustion are expelled through a valve, after which the above-described operation is repeated for the next stroke.

"According to another arrangement, the combustible gas and air or other gas are employed in a compressed state in the engine. For this purpose the engine may operate either as above described, the gas and air being simply compressed to the requisite degree before being introduced into the cylinder, or, by preference, the compression is effected in the cylinder itself in the following manner: The cylinder is constructed of greater length than the stroke of the piston, so that there is a space beyond the latter when it is at end stroke. Assuming this space to be filled with a portion of the gaseous products of combustion resulting from the last stroke at atmospheric pressure, the piston in performing one part of its stroke draws in atmospheric air, after which it will draw in the combustible mixture during the remainder of its stroke. The cylinder will then be filled with three strata of different gases, more or less intermingled at their junction, namely, a stratum of products of combustion next the piston, then a stratum of air, and lastly the combustible mixture. The piston then performs its return stroke, whereby the gaseous charge is compressed into the before-mentioned space at the end of the cylinder. The gases will in this condition still retain their stratified position, the particles of combustible mixture being diffused to a certain extent through the other strata. The charge is now ignited and burns gradually and with the same effect as described with reference to the first arrangement. On the return stroke the products of combustion are expelled with the exception of the quantity contained in the space at the end of the cylinder. The regulation of the power of the engines operating according to the above-described invention is effected simply by admitting more or less of the combustible gas for each charge, this being done by regulating the time of opening and closing of an admission valve on the gas supply pipe. The motion of this valve is regulated by a rotating cam capable of being adjusted longitudinally on its shaft by any suitable known arrangement of governor."

Mr. Aston went on to state that engines had been made in the way described in the first part of the specification and worked well, but not so well as those described in the second part, beginning with the words, "according to another arrangement." The patentee, according to one method, introduced air, and then behind it the combustible mixture without compressing at all, and he fired them in that state. But he said, "If you like you may use them in a compressed form."

Mr. Aston then proceeded to explain at much length how, by the use of a cylinder longer than the piston stroke, compression would be effected in the same cylinder in which combustion took place, as in Fig. 4, where A is the cylinder,

FIG. 4



ABEL (OTTO), 1876.

B the piston, D the slide, E an exhaust port closed by a valve, not shown. When the piston is at the inner end of its stroke its face is at a; the slide D is in such a position that as the piston begins to move out, air entering by the aperture D^1, and port, C, until the piston reaches the point, b, when the slide reached such a point that gas is drawn in mixed with air until the piston reached the end of its outstroke; when the instroke was complete, and the compression effected, the slide moves so as to admit the gas flame, H, igniting the charge.

Mr. Aston laid much stress on the plaintiff's statement that the cylinder would be stratified. The work of compression was a very important function of the engine, for the proportions that constituted an explosive mixture were, say, 1 of gas to 8 of air at atmospheric pressure; but if we had a mixture in a compressed form, we might have a mixture in as high a proportion as 15 or 16 of air to 1 of gas.

Mr. Aston then, by means of a model, explained in detail to the Court the whole action of the Otto gas engine; and as this is no doubt fully understood by our readers who have followed us so far, it is unnecessary to say more on this point. Resuming, he called the attention of the Court to the statement in the specification, which runs: "It will be evident that if the space a^1, or a separate chamber, such as an air vessel," etc., what the patent then said was: "You need not always draw in when you make your first stroke, a charge consisting partly of air and partly of combustible mixture, provided that you have your chamber—which may be called the residuum chamber—sufficiently large to contain a charge of incombustible fluid, such as is left after the last charge has been fired, to act as a cushion in the way described."

Mr. Aston then defined the invention in the following words, as "consisting in introducing or admitting into the working cylinder a charge of a combustible mixture and an incombustible fluid in such a manner that the combustible mixture was dispersed in a gradually disseminated condition among the incombustible fluid, more dispersed at parts distant from, and less dispersed at parts near to, the place of ignition; thereby effecting, when the charge was fired, gradual combustion, gradual development of heat, and gradual expansion of the gases, and so utilizing most effectively the motive power, and avoiding shocks and waste of heat."

The claiming clauses, he submitted, entirely coincided with the definition which he had given as constituting a fair summary of the invention. The first claim was virtually "having in your cylinder a charge properly admitted, and firing it so as to produce these new results," namely, the avoiding of shocks and loss of heat. The second claim was "compressing by one in stroke of the piston a charge of combustible and incombustible fluid drawn into the cylinder during its previous out-stroke, so that the compressed charge when ignited propelled the piston during the next out-stroke, and the products of combustion were expelled by the next in-stroke." These covered the whole cycle of operations. The third claim was for "regulating the admission of the combustible gas or vapor to the cylinder by means of a separate slide controlled by a governor;" and the fourth claim was for "the construction of a gas engine substantially as herein described in reference to drawings, Figs. 2 to 18."

Mr. Crossley had found that Messrs. Linford & Co. were making gas engines practically the same as those patented by Mr. Otto, differing in form, as might be imagined, but constructed on practically the same principles; that upon this the action was brought.

Mr. Aston then proceeded to state various particulars of breaches, and to give the names of persons who had purchased engines from the defendant, and dealt with the defense. "The defense is a denial that Abel was the true or first importer or inventor—denial that the invention was entirely new, that the invention is entirely useful, and denial that the letters patent are valid." This was practically a denial that Mr. Charles Denton Abel was the true and first inventor; that the invention was new, and that it was useful, and that the specification was sufficient. Furthermore, the defendants relied in same measure, on certain prior specifications—Johnson, 1860 and 1861; Barbacci, 1868; Abel, 1866; Barrett, 1838; Boulton, 1866, 1867, and 1868.

Mr. Aston then went on to say that none of these affected his client's position. It was possible that some persons had proposed to introduce small quantities of atmospheric air into the cylinder of gas engines to nullify the evil effects of carbonic acid produced in the cylinder, but he should like to see the engine in which this was done. He did not believe it could be done. There was, of course, variety of form and appliances, but these the Court would remember constituted no part of the invention claimed. The patentee said, 'You may vary the appliances and the form, but I will tell you the way you may do it best," and he gave three modifications. The defendant varied the number of his out-strokes and in strokes, and the engine he made was different in shape, but in the long run he produced the same results as the plaintiff in the same manner. The defendant had two pistons working in one cylinder. These pistons, instead of receding from and approaching the residuum chamber which is at the end of the cylinder, approached one con-

* The learned counsel illustrated this for the Court, by first putting into the cylinder of a model, white and afterwards red wool.

tained between them and in the middle of the cylinder, and that was the only difference; all the rest as to change of form followed naturally as a consequence. He then described the action of the defendant's engine at length, claiming that this action was in all essential respects identical with that of the plaintiff's engines.

After a lengthy examination of witnesses the Vice-Chancellor decided that Johnson's patent contained what the plaintiff claimed, and the suit was dismissed.

STORING COMPRESSED AIR OR GAS.

ALEXANDER JAMES, M.D., of Edinburgh, Scotland, has invented and patented in this country certain new and useful improvements for storing compressed air or other gas in vessels, of which the following is a description:

This invention relates more particularly to a method and means for storing compressed air for motive power for locomotives or cars for railroads; but it may also be applied to the storage of compressed air or other gas for such purposes as sewing machine motors, or portable illuminating gas apparatus on railroad trains, and for any and all purposes wherein compressed air or gas is required to be stored.

The invention partly consists in a method of compressing air wherein the adhesive attraction of an absorbent material or materials is made to assist dynamic power and static pressure in reducing the volumes of gaseous bodies in confined spaces or inclosures.

The invention further consists in an apparatus for storing compressed air or other gases, by which the force of adhesion existing between gases and absorbent substances is made to act, in conjunction with mechanical pressure, to condense a larger quantity of gas in a given cubic space than could be otherwise stored therein, said apparatus consisting substantially of a reservoir or receiver for the compressed gas and a porous substance or substances possessing absorptive power confined in said reservoir or receiver. Charcoal made from box-wood or cocoanut shells, especially the latter, possesses this power of absorption to a very high degree, and sponge platinum to a still higher degree, and the absorptive power of charcoal treated with a solution of platinum is greatly increased.

In the particular case of compressed air locomotives there has been considerable difficulty experienced in storing a large supply of compressed air without adding too much to the weight. By the use of this invention this difficulty will be, to a great extent, obviated, and this very desirable means of locomotion made more practicable than hitherto.

A tank or reservoir is constructed of boiler iron or steel, and filled with an absorbent material. The tank is hermetically sealed when it has received its charge of material.

A material that absorbs a volume of air or gas at atmospheric pressure will absorb nearly or quite the same volume at higher pressures. It logically follows that a material capable of absorbing more than its own volume of a gas will, by its inherent condensing power, increase the volume of air or gas which can be introduced into a confined space in which such material is placed. This principle is the basis of the method of storing air or gas, which consists in compressing the air or gas by dynamic power into a tank or reservoir containing a material capable of absorbing more than its own volume of the air or gas till a stated pressure of the unabsorbed air in the tank is attained, and then hermetically sealing the reservoir or tank. When the pressure in the tank is reduced by consumption of the air or gas therefrom, the absorbent material yields up so much of the air or gas condensed therein as will reduce the amount still retained by it to the volume, under the reduced pressure, which such absorbent material or substance normally condenses into its pores.

The inventor claims:

1. The method of storing air or gas herein described, which consists in first compressing the air or gas into a receptacle containing a material or substance capable of condensing into its pores more than its own volume of the air or gas under pressure, and then hermetically sealing the receptacle, whereby more air or gas can be condensed in said receptacle and taken therefrom under lower pressure than could be done without the presence of said material in said receptacle, substantially as specified.

2. In an apparatus for carrying out the herein described process of storing compressed air and other gases, a reservoir or vessel intended for the storage of air or other gas under pressure, and a porous substance or substances possessing high absorptive properties confined in said reservoir or vessel, substantially as and for the purposes described.

DRIVEN WELLS FOR FIRE PURPOSES.

WE have frequently in these columns directed attention to the value of driven wells, for furnishing an abundant supply of water for fire extinguishment. We would by no means recommend them as a sole source of supply, but in cities where there is a scarcity of water in certain localities, and in small places where the dependence is upon small streams and cisterns, driven wells can usually be put in successfully and at small cost. Their value is being more and more recognized by private parties in the East, but in many sections of the West they have long been the main dependence of individuals for their supply of water both for domestic and business purposes. In this city there are many high points where the water supply is insufficient, even when the reservoirs are full, and many a time the firemen have been crippled in their efforts to put out fires because of the impossibility of procuring from the mains sufficient water to supply the number of engines it was desired to employ. Yet the enterprise of private parties in putting down driven wells to obtain water for manufacturing purposes, and thus save the water tax, has demonstrated the feasibility of obtaining abundance of water by this means. About forty feet below the surface of New York city, varying but slightly in different localities, there is an abundant supply of pure water—the genuine Manhattan. This has been proven by means of hundreds of wells sunken through the surface stratum, and thence through a bed of clay down to the "second vein." The former is contaminated by the drainage above, but the latter is of a delicious coolness, averaging about 56 deg. all over the island. As the temperature of the Croton in August and September ranges from 70 to 80 deg., there is a difference of from 20 to 25 deg., which in many instances, among wholesale consumers of water, effects a great saving in ice, as well as of the usual tax for Croton. The quality, however, is not invariably good, as at the Windsor Hotel, where it is impregnated with iron, injuring it for culinary purposes. Yet in most localities the water is of excellent quality, and is preferred to the Croton. In the great building of the Western Union Telegraph Company all the water used is supplied by a gang of driven wells in the basement. A powerful steam engine lifts the water to a tank in the roof—which towers many feet above all neighboring buildings—and thence distributed throughout the building generally in any desired quantity. These wells are inexhaustible, and the supply sufficient to supply the entire block. The quality of the water is pronounced by those who use it to be better than the Croton, and as the consumption of water in the building is very great, the saving in water tax amounts to a large sum. There are twenty-five of these wells in the basement, but only a portion of them are in constant use; they are simply iron tubes driven into the ground about twenty feet, making the depth of the wells about forty feet below the surface of the street. Despite an occasional drawback arising from mineral impurities, the demand for wells is more incessant, as the local supplies are so much purer and cooler, and besides render the well-owner independent of the enormous charges exacted where water meters are attached to the premises. The St. Denis Hotel, for instance, is saving $1,200 a year. There are the Sisters of the St. Francis Hospital, who had a well put in last winter on Fifth street, near Avenue B. At the beginning of the work there was discouragement, from the fact that the driving instrument was compelled to penetrate eighty feet of quicksand before reaching clay, but beneath the clay and a bed of gravel there was found water abundant and pure—wells supplying fifty thousand gallons per day. The Croton being cut off, and the wells run by steam power required for other purposes, the saving is $2,000 a year. There are already in the city five hundred wells, supplying five million gallons per day, and it is certain that these will be definitely increased. Mr. Allen Campbell, Commissioner of Public Works, advocates dependence on driven wells, so far as possible, as an auxiliary to the Croton, and in order to postpone that evil day when an enlarged Croton aqueduct will be necessary at an enormous expense. Well water being so much preferred by brewers, and in making bread, such great quantities being consumed for manufacturing purposes, hydraulic elevators, filling boilers, etc., the new mode of supply becomes a public boon as well as a relief to those who are terrified by meter charges.

A number of large establishments have supplied themselves with wells expressly with reference to fires. At the Berkeley House, corner of Fifth avenue and Ninth street, they have an independent well thus designed, always ready. At R. H. Macy's, corner Fourteenth street and Sixth avenue, a fine well has just been finished at the new building. At Hecker's flouring mills there are five driven wells, each of which yields six thousand gallons a day, and they are never affected by drought. The most frequent modes of sinking wells are by driving or boring. By the former, no attempt is ever made to penetrate a rock, for when an obstruction is encountered the tubes are sunk elsewhere, and it often happens that they can clear the rock within a short distance, as at Ryerson & Brown's livery stable on Forty-fifth street, where rock was struck at thirty-three feet, and again in the rear, at twenty-eight feet, but on a final test a copious well was struck about midway, at a depth of forty-five feet. When wells are bored, as at the Mutual Gas Light Company's Works on Eleventh street and East River, there is sometimes heavy expense to no profit—in this amounting to $15,000—after vainly penetrating fifteen hundred feet. The difference between the supply of water at different localities in the city is explained by the variations in the substance through which the water flows. In passing through coarse gravel the yield might be fifty gallons a minute; if through sand, perhaps only ten gallons. Almost invariably the second vein is found within lifting distance of the surface, without the necessity for the excavation. Dug wells have a difficulty in excluding the surface water which percolates through the stone curbing, as at the open well of the Manhattan Gas Works, East Fifteenth street. Among other notable wells should be mentioned Shook & Everard's breweries, on West Tenth street and Washington; a two-inch sixty foot well formed of six tubes, and yielding a hundred and twenty-five gallons a minute. The Russian Vapor Baths, on Lafayette place, have three two-inch wells, producing fifty thousand gallons a day. The water is very pure, and the temperature is 55 deg. at all seasons. Edward Ridley & Sons, on Grand and Allen streets, have a single tube that supplies twenty-five thousand gallons per day. It is calculated that the entire city could be similarly supplied at a low estimated cost.

What is true of New York city is true of two-thirds of the cities and villages of the country. In many places considerable expense has been incurred in providing cisterns for fire purposes. These have to be filled artificially, and are liable to be exhausted in an emergency. An equal sum expended for driven wells, would, in a majority of cases, serve the purpose far better, and provide an inexhaustible supply of water. Driven wells are not experimental, but have been successfully used for many years by many thousands of persons. Why they should not be utilized by corporate authorities as well as by individuals, is a conundrum yet to be solved.—*Fireman's Journal.*

SPECIFICATIONS OF NEW STEAMER FOR THE MEXICAN NATIONAL CONSTRUCTION COMPANY.

MR. SAMUEL HOLMES, of this city, has just issued the plans and specifications for a new iron twin-screw steamer, to be built for the Mexican National Construction Company. Her principal dimensions are as follows: Length between perpendiculars, 160 feet; extreme beam, 34 feet; moulding depth, 10 feet 6 inches.

The stem and stern posts are to be of bar iron, 6x2 inches, to run well into keel. The stem at keel to be forged to shape of keel-plate. The stern post to have two gudgeons forged on, 5 inches deep, to receive rudder pintles; also a socket at heel. Keel, to be formed by flat plate amidships, 18x½ inches for two-thirds length, bent at ends to shape, and reduced to 7-16 inch thick. Frames to be of angle iron, 3½x3x⅜ inches, spaced 22 inches apart, moulding edge to moulding edge. To extend from keel to gunwale in one length, and to have coupling pieces at center 4 feet long, extending as far fore and aft as practicable. Bulkhead frames to be double. Floors to be of plate iron, 16x⅜ inches, spaced one to each frame, and to be bent at bilge, and extend up the frame a height of twice the center depth. The floors under engines to be 7-16 inch thick. Limber holes to be punched in each floor, etc. The bulkhead floors to be 3 inches deeper to facilitate riveting. Reverse frames to be of angle iron, 2½x2½x5-16 inches, extending across the top of each floor plate as far as bilge and gunwale alternately. The reverse bars in engine and boiler space to be double, and under the engines to be the size of frame angle iron (3½x3x⅜). The butts to be all properly shifted across the center line and to have straps fitted. To have a doubling lug inway of all keelsons. Middle line keelson to be formed by intercostal plates ⅜ thick extending 4 inches above the top of floors, and to have double angle irons 4x3x7-16 fore and aft on top of floors and on keel plate. Corner angles 2½x2½x5-16 to be fitted vertically and connecting intercostal plates and floors. Limber holes to be punched in each frame space. Butts of fore and aft angles to have coupling pieces fitted 3 feet long, same size as keelson, with chamfer taken off corner to fit snugly. Sister keelsons, to be intercostal and placed midway between center keelson and lower bilge keelson. To be formed of plate iron 5-16 thick, with double angle iron 4x3x7-16, all fore and aft as far as practicable on top of floors and single to shell, vertical corner angles to be fitted of 2½x2½x5-16 angle iron. Limber holes to be punched in each plate. Butts of fore and aft angles to have coupling pieces fitted 3 feet long, same size as angles. Bilge keelsons, to be fitted at upper and lower turn of bilges formed of double angle irons 4x3x7-16 back to back, extending all fore and aft and finished at ends with breast hooks of ⅜ plate iron not less than 4 feet long in fore and aft directions. All butts to be covered with coupling piece 3 feet long, same size. Main deck beams, to be formed of T bulb iron 7x5 inches for ⅝ vessel's length amidships. The beam ends to be split and have knee welded in. The knee to be 18 inches deep, with knees welded, and to be securely riveted to the frame with six rivets in each knee. Beams at ends to be formed of angle iron 6x4x7-16 18 inches knees welded at ends and riveted as above. Beams to be fitted to each alternate frame. Where the bulkheads come, double angle irons 3x3x⅜ to be fitted in place of bulb beam. Stringer plate to be of plate iron 36 inches wide by 8-16 inch for ⅝ vessel's length amidships, and from thence gradually tapering to 18x7-16 inches at ends. The stringer to be riveted on top of beams at sides of vessel. Butts to be shifted not less than two clear frame spaces away from butts of sheer strake. Gunwale bar to be of angle iron 3x3x⅜ inches, riveted on top of stringer plate and connecting stringer and sheer strake together; to extend all around the vessel and be properly calked. A doubling piece to be fitted in any of all butts 2 feet long. To form the scuppers (four a side in number) the gunwale angle iron to be stopped 3 inches (or size of scupper) apart, and a coupling piece, same size as bar, 4 feet long, to be fitted under the stringer plate, to make up the strength of bar where it is cut. Gutter waterway, to be formed by fitting an angle iron 3x3x⅜ inches, 12 inches from sheer strake, all around the vessel. Said angle to be securely riveted to the stringer plate and calked. Tie plates, to be of plate iron 9x⅜, riveted on top of beams spaced 14 feet apart, extending all fore and aft. Diagonals, to be fitted of plate iron, 9x⅜ inches, in three sets, across the deck and securely riveted to the beams and to the stringer plate at sides by butt straps. Shell plating, the bottom, bilges, and sides, to lower edge of sheer strake, to be 7-16 thick for half length amidships, ends ⅜ thick. The sheer strake to be ½ thick for half length amidships, ends 7-16, extending 7 inches above deck beams. No plates to be less than five spaces of frames in length, except the fore and aft hoods. No butts of outside plating in adjoining strakes to be nearer each other than two spaces of frames, and the butts of the alternate strakes not to be under each other, but shifted not less than one frame space. All butts of plating, where practicable, to be planed and fitted close, the edges of the plating to be sheared from their faying surfaces, or the burr caused by shearing to be carefully chipped off, and all outside edges of plating are to be either planed or chipped fair. The butts and edges to be carefully calked. Butt straps to be 9½ inches wide. Bulwark to be 2 feet 6 inches deep from stringer plate to underside of rail. To be formed of plate iron 4-16 thick, and have angle iron 3x3x⅜ on top edge, running all around the vessel. Stanchions, 1⅜ round iron, to be fitted from gutter bar to underside rail, spaced about six feet apart, or one at butt and one at middle of plate. Butt straps, 4 inches wide. Liners—the space between the plating and the frames to have solid filling or lining pieces in one length, closely fitted, to be of the same breadth as the frames, excepting in wake of bulkheads, where they are to be fitted in a solid plate for the frame before to the frame abaft the bulkhead. Riveting and rivets. The landing edges of outside plating from keel to upper turn of bilges to be double riveted, and from upper turn of bilges to lower edge of sheer strake to be single riveted, the lower edge of sheer strake to be double riveted. The stern and sternpost, butts of outside plating, breasthooks, transoms, stringer and tie plates on beams, and all longitudinal ties to be double riveted. The butts of outside plating to be chain riveted, and to have a space equal to twice the diameter of the rivet between each row. The landing edges of plating, where double riveted, to be 4½ inches, and 2½ inches where single riveted. Butts of bulwark to be single riveted. The rivets are to be of the best quality and ¾ inch diameter for 7-16 and 8-16 plating, and ⅝ inch diameter for 5-16 and ⅜ plating. The rivets to be increased in size under their heads to fill the rivet holes. Bulkheads to have four water tight bulkheads to extend from the floor-plates to the main deck. The bulkheads to be spaced as follows: Forward, a collision bulkhead; a bulkhead at each end of engine and boiler space, and one at after end of vessel. The thickness of plating to be 4-16, fitted between double frames. Liners, as mentioned, to be of plate iron, in one piece, extending from frame before to frame abaft bulkheads. The bulkheads to be supported vertically by angle irons 2½x2½x5-16, spaced 30 inches apart and to be efficiently connected and riveted thereto and to the corresponding floors and beams. Bulkheads to be calked and made thoroughly water-tight. Pillars to be of round iron, or tubes 2⅛ inches diameter, spaced one to each beam, for ⅝ length amidships, and under each alternate beam at ends. Bunkers to be formed of plate iron 4-16 thick, stiffened with angle irons, 2½x2½x5-16, spaced 30 inches apart, to be efficiently stayed with round iron stays from frames, and connected by fore and aft angle iron to tieplates on deck beams. Rudder.—The stock to be 4⅛ inches at the head and 2½ inches at the heel. The back frame to be 2½x2½ inches. Two pintles to be forged on 5x2⅜ and small pintle at heel 2x2. The rudder to be plated with ⅜ iron, and the empty space between plates to be filled in solid with pine paid in seams with pitch. Hatch Coamings.—To be of plate iron 12 inches high above beams, by ⅜ thick; deck plates around hatch 9x⅜; angle iron 3½x3½x⅜. Mast Partners.—Of plate iron 4 feet wide and riveted to three beams ⅜ thick. Deck Plates.—Of plate iron under each hoisting engine and under windlass, properly riveted to three beams if possible. Ports and Scuppers.—Five side ports to be cut in bulwark 20 inches square; four scuppers to be fitted on each side 4x3 inches; a cast iron lip to be riveted on sheer strake to throw the water off. Moulding.—A half-round iron moulding to be riveted on top of sheer strake, extending all around the vessel; moulding to be 3⅛x1⅛. Cement.—

The frames and plating of the bottom to the upper part of the bilges to be thickly and efficiently covered with Portland cement, which may be mixed with sand in proportion, ⅓ cement, ⅔ sand. This must come even with all limber holes, which have to be cut in all floors at each side center line, and in intercostal plates between each frame space. Outside shell riveting to be cemented as usual before painting to make smooth work General Clause.—The whole of the material and workmanship to be strictly first-class; all defective material to be replaced, and all the work and material to pass the inspection of the superintendent (Mr. Samuel Holmes, New York), in accordance with the specifications.

Main Deck—to be of yellow pine 3x5 inches, to be well secured to deck beams by half-galvanized bolts and nuts. The deck to be calked with three threads of oakum, and properly paid and made thoroughly water-tight. Margin plank, to be 9 inches wide, of yellow pine, thickness of deck. Main rail, to be 10x3½ inches, of oak, secured to angle iron on top of bulwark and to stanchions as described

Ceiling, to be 2½ inches in bottom, close ceiled to turn of bilge, and above this, battens 2 inches thick, spaced berth and strake. The ceiling in center to be in hatches so as to clean out the bilge. Windlass, to be a patent American Ship Windlass Co. windlass, for the 1 1-16 inch Stud cable chain with messenger chain attachment to be driven by froward hoisting engine. Pumps, two hold bilge pumps, to be fitted with brass chambers 6 inches diameter, fitted complete with brakes, pipes, etc., ready for use; lead suction pipes into bilge, to be fitted; two composition fire engine and wash-deck pumps, to be fitted and so arranged that they can pump the bilge or draw from the sea, with proper stop cocks. The suction pipes to have a 3-way cock to arrange the work of pump. The fire and wash-deck pumps to each have 100 feet hose (rubber) and nozzles. Main house to be of iron. The coamings to be 12 inches high above the deck beams and ⅜ thick, securely riveted to the tie plate by angle iron 3x3x⅜ inches. Framing of house to be angle iron 2½x2½x5-16 inches, spaced about 24 inches apart, with as large knees as possible at top and bottom of 4-16 plate iron. Sides and ends of house 3-16 inch plate iron, flush butted, with butt strap outside to form panels. Beams to be 2½x2½x5-16 spread, one to each frame. Stringer to be fitted at sides 12x4-16. All to be single riveted, with ½ inch rivets finished off smooth, the rivets to be cemented over and rubbed down smooth for painting. Masts and spars.—Two yellow pine masts, 16 inches diameter, at deck, as per plan. Two gaffs fitted to use for hoisting cargo, with all necessary iron work. Rigging.—Standing rigging to be galvanized wire, 3 shrouds a side, 3 inch wire. Forestay, single 3¾ inch wire. Mainstay, double 3 inch wire. Running rigging, Manila. Sails of cotton canvas. Foresail, No. 3; mainsail, No. 3; stay-foresail, No. 2.

The vessel to be driven by twin screw surface condensing engines, turning a screw under each counter 7½ feet diameter. It is the desire of the company proposing to have this vessel built that the engines be independent of each other and have separate boilers. And in order to relieve the builders from adding the expense of new patterns, it is the wish to adopt the several builders' own patterns and receive their propositions for compound engines with sixteen inch high-pressure cylinder, and thirty inch low-pressure cylinder, by twenty-two stroke, 16 and 30x22, or equal to this. Again, it is desired to have propositions for a simple direct acting, single cylinder, surface condensing engine, working upon each shaft, with independent boilers of ample capacity; cylinder to be 22 inches diameter by 24 inches stroke of piston, or its equivalent. The boilers to be of cylindrical return tubular description, tested for 80 pounds steam, and whichever style of engine is adopted the boiler must be of ample capacity and steam freely without forcing by jet or other artificial means. Boilers to connect to one stack of ample diameter and height. Line shafts to be of wrought iron, 6½ inches diameter, with solid or cast-iron couplings, truly faced and secured by six 1¼ bolts and a steel cross-key. Shafting to be covered with brass ⅜ inch finished size in way of after bearings and stuffing boxes. Pumps, an independent donkey pump to be fitted to feed boilers. Feed pumps to be on main engines. Bilge pumps also on main engines. All pumps to be arranged with connections to draw from the holds of the vessel for feeding, circulating, or discharging overboard. Bilge connections to be lead pipes, properly cased, and rose ends fitted and placed between the floors at extreme after ends of each hold, from which points the water must be drawn when pumping ship.

IRON AND STEEL UNDER THE "HAY PROCESS."

By A. T. HAY, of Burlington, Iowa.

THERE is perhaps no subject in this, the iron age, within the wide range of practical engineering which has appealed to the earnest consideration of the scientist, metallurgist, and engineer more than that of the treachery of iron and steel in steam vessels, railway rails, bridge members, etc.

It is not strange, however, that wild theories, crude ideas, and hasty conclusions should find their way into public prints and scientific journals so long as there is no recognized science in what constitutes iron and steel, to predicate observations and experiments upon. And allow me to say, until there is a recognized science and an established constitutional make-up of the different varieties of iron and steel that is practically understood and appreciated by metallurgists, engineers, and consumers, there will be but little pecuniary benefit derived from or safety secured by random inspection or mechanical testing as regards stability, wherein they enter in land and marine construction.

Iron chemically pure is known to be a soft, weak, unstable, elementary metal, whereas homogeneous fine iron is practically an alloy containing several other rare elementary metals, including two or more metalloids chemically combined; while common coke iron and low grades of so-called Bessemer steel made therefrom are simply semi-mechanical mixtures of dissimilar stocks containing unreduced refractory oxides promiscuously combined with phosphorus, sulphur, silicon, etc., including free and combined carbon, *i. e.*, a heterogeneous amorphous mass of elementary substances.

Now, these several unrevived refractory oxides are not only sources of mechanical weakness in themselves—like knots in lumber—but they are sources of chemical disintegration. Every one of these hard silicious knots is an electro-negative center—a direct source of disintegration from voltaic action that is furthered by the corrosive elements or substances contained in water, including the crystallization of the iron from vibration, etc. Hence, rapid deterioration from both chemical and mechanical causes.

Iron is not found in native masses to any extent (and then never chemically pure), but in a state of oxide, mineralized with other elementary metals and metalloids. And it is upon these earthy so-called impurities, their proportion, electrical and pyro-electrical relation, process of reviving and manner of working, that depend the commercial value, adaptability, economy, and durability of any given product, that is, the adaptability of any piece of iron or steel for any given purpose depends entirely upon the number, kind, and relative proportion of the elementary rare metals entering into its constitution as an alloy in a metallic state.

It is upon this principle that we have Swedes iron, Norway iron, Russia iron, Scotch iron, Low Moor iron, Juniata iron, Brown's U. S. iron, etc. Each one of these several fine irons has a different constitution, a special adaptability and a world-wide reputation for its special superior quality that is derived from and assimilated with it by nature in the original ore peculiar to the locality wherein it is mined. It is these several rare metal alloys that constitute the blood, so to speak, that give to iron its true quality, valuable property, durability, etc., against chemical and mechanical influences. Such irons are isomorphous by nature and homogeneous in character. Whereas, a dissimilar mixture of different stocks of iron imperfectly revived, irregular in constituent elements, produce those heterogeneous, amorphous products known as common iron, or the so-called low steels that contain raw cinder or unrevived metallic oxides and other elements or factors of mechanical and chemical weakness, sources of deterioration and rapid decay.

With the foregoing premises I opened my investigation of iron and steel from an original standpoint that takes into consideration the chemical, electrical, and pyro-electrical relations of iron to all its mineralized elementary metals and metalloids with which it is found assimilated or combined within its native ore. In these I find its constitution and a scientific solution of the whole question as pertains to its adaptation and stability.

Iron belongs to or is closely allied to a large family of earthy metals with which it is isomorphous, and when fully revived to a metallic state they, the rare metals, alloy with it in indefinite proportions. These allied metals, are, as far as ascertained, some sixteen in number, and they are divided into two electrical series toward iron as regards oxygen; seven are electro-positive, and nine are electro negative at normal temperature; two of the latter are pyro-electric, *i. e.*, they change their polarization toward iron by a change of temperature. It is in these electrical relations that I find the property of homogeneity, malleability, ductility, and tenacity; also crystalline characteristics, "cold short" weakness, with "red short" and "warm short" peculiarities. That is, upon these deductions we may formulate and produce any grade, peculiarity, or variety of iron desired for any given purpose, having the greatest homogeneity, malleability, ductility, tenacity with resistance to corrosive and thermic influences combined. These several allied isomorphous metals play about as important a part in the make-up of fine iron and steel as the vowels do in the make-up of fine English language.

There is a principle in chemistry that precludes the making of a double salt from any two metallic oxides of the same isomorphous group. This principle holds good in an isomorphous alloy with iron wherein the several metalloids will choose or combine with their first affinity analogous to the effect of manganese upon molten iron in the presence of oxygen. As is well known, the oxygen leaves the iron and combines with the manganese, and so it is with the several metalloids, neither will combine with iron in the presence of its isomorphous affinity. The best piece of iron to resist tension, vibration, corrosive and thermic influences, and at the same time remain malleable, ductile, and tenacious at all temperatures, will be that combination in alloy of isomorphous elements that will assimilate with or take up and utilize the greatest amount of sulphur, phosphorus, silicon, and other negative influences, leaving the iron the neutral or electro-negative metal in the alloy, *i. e.*, complex iron is stable and reliable, clear iron unstable and treacherous.

Practical experience demonstrates that in about the ratio as the rare metallic oxides and the metalloids have been reduced to the minimum by the basic and other fluxing direct processes, the malleability and tenacity attained thereby is of a doubtful character, *i. e.*, unreliable and treacherous in the extreme—instability seems to be inherent in all those so-called mild steels, *that consist in a low carburet of clear iron.* The fact is, such metal has no constitution, and it stands as to genuine steel or fine iron about as bass wood stands to white oak for structural purposes. Some of these Siemens-Martin steels are as unreliable as untempered glass, and analogous thereto—will crack or split with a change of temperature or from the effects of cold water. I know of one railway corporation that had some thirty-five box plates break within a year, and nearly all of them gave way standing idle, dry, or when being filled up with cold water. But I have not found any such weakness where genuine crucible steel or double-worked fine charcoal homogeneous iron was used. Neutral ores containing the requisite elementary metals and metalloids assimilated in such proportions as will flux and revive themselves under the ordinary charcoal process into alloys, having the durability and valuable properties of fine iron or steel, are very rare as compared with the whole resource of iron.

A "red short" iron is one that contains pyro-electric elements: that is, an elementary metal or metalloid that changes polarization from an electro-positive relation to that of an electro-negative relation at a red heat when the oxygen and other negative elements present act on the iron. Carbon is also pyro-electric and changes polarization with iron several times between normal temperature and fluid heat. At about 700 deg. Fahr. it is extremely positive when a piece of steel is flexible or very tough; at about 1,400 deg. Fahr. the carbon becomes intensely negative when a piece of heated steel is at that temperature; the iron therein being the positive is "hot short" to friable, and at fluid heat the carbon again assumes the electro-positive and the iron becomes impervious to oxygen as is every day exemplified in the casting of steel and puddling of iron.

"Cold short" iron contains electro-negative elements that render the iron electro-positive at normal temperature, when phosphorus that is ever present in such stock assumes the negative thereto. Now this so-called "cold short" iron may be changed to a malleable, ductile, fibrous iron by alloying it with electro-positive isomorphous metals sufficient to take the metalloid from the iron which gives to it a negative reaction. One of the finest, most ductile, and tenacious pieces of iron I ever saw was made from "cold short" stock alloyed with three rare elementary metals, and an assay showed as much phosphorus in the bar as in the original pig.

"Warm short" is another weakness known to certain grades of iron. It contains elements that are positive at normal that become negative toward iron at from 400 to 600 degs. Fahr. when the iron is extremely weak, that change to a positive and support the iron above 600 degs. Fahr., when it again toughens. Fine iron and true steel, as is well known, are easily injured or destroyed by overheating in a blacksmith fire. That is caused by the carbon present in the fuel being intensely negative in such temperature when the rare metals that are essential in fine iron and steel oxidize, which converts the one into brittle or burned iron, and the other into a brittle white carburet of iron. A demonstration of this fact may be had by restoring burned steel to its original fine quality through the agency of an isomorphous sponge containing the essential elementary metals of fine iron or steel, which may be added as a flux at a welding heat or in a molten state; hence, the theory that the carbon burns in overheated steel is not the fact, since steel may be restored without carbon.

To further demonstrate this, the finest grades of high steel may be successfully worked and welded at a yellow white heat by fluxing the metal with said isomorphous sponge, which absolutely refines and otherwise improves it; 3 per cent. of said isomorphous sponge added to Bessemer metal will set free or eliminate the oxygen from the otherwise refractory oxides contained therein, and at the same time add an alloy of the essential elementary metals sufficient to convert the whole charge into a true steel, having all the valuable qualities and properties of crucible steel, that may safely carry 0·60 to 0·90 of 1 per cent. of carbon.

When homogeneous fine iron and true steel are polished and etched in an acid solution, the action will be uniform over the entire surface exposed, and if washed off in an alkali solution the oxidized surface will remain bright. Such metal contains the elements for its own preservation; whereas, when common iron or Bessemer steels are treated in like manner the action will be irregular, *i. e.*, pitted and honeycombed or corroded in seams, and when washed off will turn black. Such an iron or steel contains the elements of its own decay. The economy, durability, and safety of iron and steel depend entirely upon their constitutional or scientific make up for practical purposes.

Having from hypothetical induction and laboratory deduction demonstrated the essential constituent elementary metals contained in the different varieties of fine iron and true steel, as also the allied elements that render iron hard, rigid, and brittle, including "red short" and "warm short" peculiarities, and having tabulated them in the order of their several electrical, pyro-electrical, and chemical relations to iron as regards oxygen, the metalloids, acids, and the alkalies, at normal and other temperature, and having previously discovered a complete and economic process of reviving the metals contained in refractory oxides in combination with iron, it was only necessary to formulate an "alloy sponge" to produce any given variety of fine iron or steel, and to apply the same as an auxiliary or secondary process to the knobbling fire or Bessemer converter to produce any desired quality of metal by eliminating the oxygen and thereby setting free the metals contained in the refractory oxides in stock, and at the same time adding such essential elementary metals necessary to produce any desired product. This investigation covers the best twenty years of my life. It is not a theory in an experimental state, but it stands forth as a verified, full-fledged scientific process. Every variety of fine iron known to the trade has been produced and reproduced from American stock. Varieties that will rival the finest Norway rod or the most durable Russia sheet have been made. Also a grade of metal heretofore unknown to the trade, having all the mechanical and chemical properties of fine iron and true steel combined, known as "Hay steel," that is particularly adapted for bridge members and other structural purposes, has been uniformly produced in large quantities.

The celebrated Glasgow, Missouri River, steel bridge, which is the first all steel truss bridge ever constructed, was built entirely of "Hay steel." The metal was furnished by Hussey, Howe & Co., Pittsburg, Pa. It was formulated by the inventor of the process, A. T. Hay, of Burlington, Iowa; blown, cast, and bloomed by the Edgar Thomson Steel Company, at Bessemer Station, Pa., under the immediate and personal supervision of C. Y. Wheeler, of the Hay Steel Company, Chicago. The shapes were rolled by Andrew Kloman & Co., Pittsburg. The bridge was constructed by the American Bridge Company, Chicago, under the general supervision of William Sooy Smith, chief engineer of the bridge, and projector of the enterprise in the interest of the Chicago and Alton Railroad Company, which was commenced, completed, and accepted within a year, and it was celebrated on the 6th day of June, 1879, by the good people of Glasgow, citizens of Missouri, and a delegation of distinguished American engineers. Since that date a swing bridge, on Kinsie street, Chicago, and a second bridge across the Missouri River, at Plattsmouth, Neb., two spans 400 feet each, being of said material. Railway rails formulated and produced under said process, containing 0·50 of 1 per cent. of carbon, are perfectly homogeneous and stand up under the heaviest traffic, and will carry over double the tonnage of common Bessemer metal.

THE MANUFACTURE AND USES OF CAST STEEL.*

THE first question which the user of cast steel has to answer is, to decide which of the three great methods of making steel produces a material best adapted to his own wants. Sir Henry suggested to you in his admirable lecture that Bessemer steel would answer every purpose for which steel is used, with the possible exception of the steel required to make Canadian axes. There can be no doubt whatever that the Bessemer steel of which Sir Henry gave you the first analysis would have made an excellent Canadian ax had it contained the proper quantity of combined carbon. The only doubt I feel is whether it could be produced of sufficient soundness without so large a percentage of waste as not to raise the price beyond that at which crucible cast steel for Canadian axes is now sold. I must confess that my experience of Bessemer cast steel would incline me to say that it could not. In spite of the prejudice that exists among consumers of steel, such is the competition of the present day, that I am sure that if steel could be produced of as good quality, and cheaper in price, by any other process than that of melting in crucibles, the present melting-furnaces of Sheffield would rapidly melt away into old bricks and mortar. I venture to express the opinion that the reason that high-class Bessemer steel is not as good as high-class crucible cast steel is because the former cannot be made sufficiently sound without the admixture of silicon and manganese, both of which substances are injurious to cast steel for most purposes. I fear that the advantages supposed to be derived from the use of manganese in the manufacture of cast steel are, to a large extent, illusory. I have frequently conversed with consumers of

* Abstract of a recent lecture at Cutlers' Hall, London, by Henry Seebohm.

steel who knew the trade before the introduction of spiegel iron into Sheffield, and it is remarkable how many of them expressed the opinion that the crucible cast steel now in use is not as good as it was when they were young.

To obtain sound ingots from high-class iron it is necessary to boil the steel for nearly half an hour after it has become fluid, and then to allow it to cool down to a certain temperature before it is poured into the mould. The process is called "killing" the steel, and it is an axiom among them that the higher the quality of the steel the more "killing" it takes. It is in this part of the process of crucible cast steel-melting that the virtue of the process consists; and the cost and quality of the cast steel produced depend in a large degree upon the skill brought to bear upon it. My theory is that the reason why high-class steel has to be so long boiled is to get rid of its occluded gas, which would otherwise produce bubbles or "honeycombs" in its attempts to escape. The addition of a portion of scrap steel much assists the "killing," as would naturally be the case if we suppose the scrap, which has been melted before, to have parted with its occluded gas in the first melting. That the presence of manganese or silicon helps largely to "kill" the steel, I account for on the theory that the carbonic acid unites with the manganese or silicon, and becomes a solid. So far my theory appears to hold water pretty well; but when I come to the fact that low-quality cast steel—for example, steel melted from Bessemer rail scrap, which contains from 0·15 ,to 0·05 per cent. of phosphorus—does not require any "killing" at all, and may be poured into the mould as hot as the strength of the crucible will allow, I am obliged to admit that I am not chemist enough to give you an explanation of the cause. The main point which I wish to impress upon you is that the much-maligned rule of thumb, which insists upon the superiority of crucible cast steel over Bessemer steel for certain purposes, may have a scientific basis, and must not be hastily set aside as prejudice.

Having decided by what process the steel is to be made, the next question that should come before the consumer of cast steel is the percentage of carbon which he wishes it to contain. When I first began business, the "temper" of steel, or the percentage of carbon which it contained, was concealed from the consumer. The following is a list of the most useful "tempers" of cast steel:

Razor Temper (1½ per cent. carbon).—This steel is so easily burnt by being overheated that it can only be placed in the hands of a very skillful workman. When properly treated, it will do twice the work of ordinary tool steel for turning chilled rolls, etc.

Saw File Temper (1⅜ per cent. carbon).—This steel requires careful treatment; and although it will stand more fire than the preceding temper, should not be heated above a cherry-red.

Tool Temper (1¼ per cent. carbon).—The most useful temper for turning tools, drills, and planing machine tools in the hands of ordinary workmen. It is possible to weld cast steel of this temper, but not without care and skill.

Spindle Temper (1⅛ per cent. carbon).—A very useful temper for mill-picks, circular cutters, very large turning-tools, taps, screwing dies, etc. This temper requires considerable care in welding.

Chisel Temper (1 per cent. carbon).—An extremely useful temper, combining, as it does, great toughness in the unhardened state with the capacity of hardening at a low heat. It may also be welded without much difficulty. It is consequently well adapted for tools, where the unhardened part is required to stand the blow of a hammer without snapping, but where a hard cutting edge is required, such as cold chisels, hot salts, etc.

Set Temper (⅞ per cent. carbon).—This temper is adapted for tools where the chief punishment is on the unhardened part, such as cold sets, which have to stand the blows of a very heavy hammer.

Die Temper (¾ per cent. carbon).—The most suitable temper for tools where the surface only is required to be hard, and where the capacity to stand great pressure is of importance, such as stamping or pressing dies, boiler-cups, etc. Both the last two tempers may be easily welded by a mechanic accustomed to weld cast steel.

Next to quality, by which is meant the percentage of phosphorus, sulphur, silicon, manganese, etc., the most important thing is temper, or percentage of carbon. For many purposes, indeed, temper is of more importance than quality. Nothing is more common than for steel to be rejected as bad in quality because it has been used for a purpose for which the temper was unsuitable.

When the steel has arrived in the user's hands, the first process which it undergoes is the forging it into the shape required. This process is really two processes. First, that of heating to make it malleable, and second, that of hammering it, while it is hot, into the required shape. The golden rule in forging is to heat the steel as little as possible before it is forged, and to hammer it as much as possible in the process of forging. It is impossible to lay down exact rules for each of the thousand-and-one tools in which steel is used. The treatment of each tool in each process which it undergoes is an art that can only be learnt by practice, and can no more be taught in a lecture than the arts of skating, riding, or swimming. The utmost that can be done is to lay down certain general rules, and, if possible, to attempt some scientific explanation of them, to elevate them above the despised position of rules of thumb. The worst fault that can be committed is to overheat the steel. When steel is overheated it becomes coarse grained. Its silky texture is lost. If the temperature be raised above a certain point, the steel becomes what is technically called "burnt," and the amount of hammering which it would require to restore its fine grain would reduce it to a size too small for the required tool, and the steel must be condemned as spoilt. Overheating in the fire is the primary cause of cracking in the water. The quality of steel may be so bad, *i. e.*, the percentage of phosphorus in it may be so high, that the amount of heat absolutely necessary to forge it at all into the shape required may cause it to crack in hardening. One of the principal reasons why a high-class quality steel is required for certain purposes is that it will suffer less injury by being heated to a greater degree, or by being heated and reheated a greater number of times than inferior qualities of steel. In heating steel the happy medium must be attained between heating it too much and too little, and between letting it lie too long "soaking" in the fire, and not "soaking" it through. Both the degree of temperature and the duration of the heat must be carefully watched. Some tools, such as circular cutters, files, etc., after they are forged into the shape required, must have teeth cut into them. Before this can be successfully accomplished, a preliminary process has to be gone through. The process of hammering or forging the steel into the shape required has hardened the steel to such an extent as to make the cutting of teeth into it impossible or difficult. It must consequently be annealed. This process, like the preceding one, is a double process. The steel must be reheated as carefully as before, and afterwards cooled as slowly as possible. Many tools are only required to be hardened on a small part of their surface, and it is important that the unhardened parts should possess the maximum amount of toughness, the minimum amount of brittleness that can be attained. These tools must also be annealed after they are forged. The process of annealing, or slow cooling, leaves the steel coarse-grained, gives it its maximum of ductility, and causes it, in fact, to approach the properties of lead.

We now come to the culminating point in our manufacture, where the invaluable property which distinguishes steel from wrought iron or cast metal is revealed, a process by which we suddenly change our steel from lead into glass—the process of hardening. In this, as in all other processes which steel has to undergo, we have to run the gauntlet of fire. We do so, however, at greater risk than heretofore. The forging of our tool is finished; it has taken the final shape to which we have destined it, and whatever injury we inflict upon it by overheating is irrevocable, and can no more be cured or mitigated by the hammer. We must, therefore, double and redouble our care, lest the temperature be raised above the point necessary to insure the required hardness. The part of the tool required to be hardened must be heated through, and heated evenly, but must on no account be overheated. Our tool must be finished at one blow—the blow caused by the sudden contraction of the steel produced by its sudden cooling in the water; and if this blow is not sufficient to give the steel a fine grain and silky texture; if, after the blow is given, the fracture, were it broken in the hardened part, should show a coarse grain or dull color, instead of fine grain and glossy luster, our tool is spoiled, and must be consigned to the limbo of "wasters." The special dangers to be avoided in hardening each kind of tool must be learnt by experience. Some tools will warp or "skeller," as we say in Yorkshire, if they are not plunged into the water in a certain way. Tools of one shape must cut the water like a knife, those of another shape must stab it like a dagger. Some tools must be hardened in a saturated solution of salt, the older the better, while others are best hardened under a stream of running water. Most tools have a tendency to water-crack if taken out of the water before they are absolutely cold. Where the edge of a tool only is hardened, care should be taken to move it up and down in the water, so as continually to change the water-level, lest the tool should crack at the water-level. Steel contracts in hardening, and contracts most when it is cooled most suddenly. If the hardened part join on to the unhardened part too suddenly, the steel at the junction will be in a dangerous state of tension which predisposes it to crack, and it is wise to lessen the amount of tension by distributing it over as great an area as possible. In some tools where the shape necessitates a great difference in the rapidity of cooling, it is wise to drill holes in the thicker parts where they will not interfere with the use of the tool, holes which are made neither for use nor ornament, but solely with the view of equalizing the rapidity of the cooling of the various parts, so as to distribute the area of tension, and thus lessen the risk of cracking in hardening.

Our difficulties are not quite over when the process of hardening has been successfully accomplished. Our steel was originally lead; it has now become glass. But we do not want glass: it is too brittle; we want whalebone. An unhardened knife would bend like wrought iron; a knife hardened only would break like cast metal. We want both qualities combined—the bending quality of the iron and the resisting quality of the metal. We want the elasticity of the whalebone. Our knife must spring like—like what ?—like *steel*. To attain this our tool must pass through the final process—that of tempering.

If you heat a piece of hardened steel slightly, and allow it to cool again, it becomes tempered. It suddenly changes from glass to whalebone; and in the process of changing its nature it fortunately changes its color, so that the workman can judge by the hue of the color the extent of the elasticity which it has acquired, and can give to each tool the particular degree of temper which is most adapted to its special purpose. The various colors through which tempered steel successively passes are as follows: Straw, gold, chocolate, purple, violet, and blue. Of course, in passing from one color to another, the steel passes through the intermediate colors. It really passes through an infinite series of colors, of which the six above mentioned are arbitrarily selected as convenient stages.

It must be borne in mind that the elasticity of tempered steel is acquired at the expense of its hardness. It is supposed that the maximum of hardness and elasticity combined is obtained by tempering down to a straw color. In tempering steel regard must be had to the quality most essential in the special tool to be tempered; for example, a turning tool is required to be very hard, and is generally taken hot enough out of the water to temper itself down to a degree so slight that no perceptible color is apparent, while a spring is required to be very elastic, and may be tempered down to a blue. If you ask me to give you a scientific explanation of the process of tempering steel, I must confess my absolute ignorance. I have no more idea why it is so than the man in the moon, and the utmost I could do would be to mystify you in talking unintelligibly about molecular rearrangement and crystalline transformations. Hardening in oil is another mode of treating steel, which appears to a certain extent to attain by one process the change from lead into whalebone without passing through the intermediate glass stage, and is of great value for certain tools.

There are many kinds of steel to which your attention should be called, but which can only obtain from me the briefest mention. A special steel for taps, called mild-centered cast steel, is made by converting a cogged ingot of very mild cast steel, so that the additional carbon only penetrates a short distance. These bars are afterwards hammered or rolled down to the size required, and have the advantage of possessing a hard surface without losing the toughness of the mild center. Another special steel, somewhat analogous to mild-centered cast steel, is produced by melting a hard steel on to a slab of iron, or very mild steel heated hot enough to weld with the molten steel, so that a bar may be produced, one half of which is iron and the other half steel, or three-fourths iron and one-fourth steel, as may be required.

A third kind of special steel, which is used for turning tools for chilled rolls, magnets, and some other purposes, is made by adding a certain percentage of wolfram, or, as the metal is more generally called, tungsten, sometimes with and sometimes without carbon, sometimes to such an extent that it can be used without hardening in water. Special steel of this kind is the finest-grained that can be produced, but it is so brittle that in the hands of any but exceptionally skilled workmen it is useless. The addition of chromium instead of wolfram has somewhat the same effect.

It is much to be regretted that no easy method of testing cast steel has been invented. The amount of breaking strain and the extent of the contraction of the area of the fracture are all very well for steel which is not hardened and not required to be used in a hardened state, but for hardened and tempered steel it is practically useless. It is very difficult to harden and temper two pieces of steel to exactly the same degree. A single test is of comparatively small value, as a second-rate quality of steel may stand very well the first time of hardening, but deteriorates much more rapidly every time it is re-hardened, than is the case with high-quality steel. Nor am I at all sure that the breaking strain is a fair test of the quality of steel. For many tools the capacity to withstand a high amount of breaking strain slowly applied is not so much required as its capacity to withstand a sudden shock. The appearance of the fracture is very illusory. The fineness of the grain and the silkiness of the gloss is very captivating to the eye, but it can be produced by hammering cold. The consumer of steel may be enraptured, if he be of a poetical turn of mind, by the superb fracture of a bar of steel reminding him of a picture by Ruskin of the aiguille structure of the Higher Alps; but, after all, this is only a dodge, depending upon the inclination of the axis of the revolving hammer to the plane of the anvil. The practical consumer of steel must descend from the heights of art and science and take refuge in the common place of the rule of thumb, and buy the steel which his workmen tell him is full of "nature" and "body."

ENGLISH RAILWAY SPEEDS.

IT may be interesting to some to have a table of the principal trains which average at least 49 miles an hour, start to stop.

		Dist.	Time.	Speed per hour.
G. N.	Grantham to Kingscross........	105¼	128	49·3
"	Finsbury to Peterboro'	73¾	86	51·4
"	Kingscross to Peterboro'........	76¼	90	50·8
"	Hitchin to Peterboro'.........	44¼	50	53·1
"	Grantham to Peterboro'	29	34	51·3
"	York to Grantham..............	83	100	49·8
"	Grantham to Retford...........	33¼	39	51·1
"	Retford to Doncaster...........	87½	21	50·0
—	(Summer Leeds Express, 3¾ hrs.)			
"	{ Kingscross to Grantham.....	105¼	122	51·7 }
"	{ Grantham to Wakefield......	70¼	79	53·4 }
M. R.	St. Pancras to Bedford..........	49⅞	60	49·9
"	Bedford to Leicester.............	49¼—	60	49·2
"	Kettering to Kentish Town.....	70⅛—	85	49·4
"	Manchester to Liverpool.......	34	40	51·0
"	Bromsgrove to Cheltenham	31⅛+	38	49·1
C. L.	Liverpool to Warrington	15⅝	18	52·0
N. E.	York to Newcastle.............	83¼	102	49.0
"	York to Darlington............	44¼	53	50·1
G. W.	Paddington to Swindon........	77¼	87	53·3
"	Swindon to Bath	29½	36	49·2
"	Oxford to Birmingham........	65¾	80	49·3

A CEMENT WANTED.

To the Editor of the Scientific American:

I would like to know if there is general need among amateur canoeists of a cement or calking substance to repair rents or holes punched by snags, cracks, etc.? If there is, I know of such an article. I am enthusiastically fond of canoeing, and have a light duck one, and would as soon think of going off on a cruise without provisions for the inner man as without this article. It is transparent, light amber color, readily applied, and ready for the water immediately after application, and calks perfectly and permanently. If there is no good preparation for this known to my fellow-amateurs, I will prepare a sample of it and forward it to you. If there is anything in use that will do as well, or well enough, I shall not trouble myself about; but, if not, I should consider it a duty to place it within reach of lovers of the delightful sport of canoeing—a sport which your journal has gone far to render general.

A CANOEIST.

Manchester, N. H.

[We think there is need for a cement such as our correspondent mentions.—ED.]

HOW SLUICE MINING ORIGINATED.

COL. EDDY, of this city, claims the credit of having originally introduced the sluice box for mining purposes, the invention owing its origin to an accidental discovery. He gives the following account of his connection with this important discovery: In the spring of 1850, when all operations were being carried on by the aid of the long tom and the rocker, he located a claim in the ravine just above the Catholic church in this city. There were several claims below him, the holders of which refused to permit him to run tailings on their ground. So he made a trough leading from his location through theirs and to a point below. On the bottom of the sluice, wherever the different sections joined, he nailed wooden cleats to keep the water and gravel from leaking through. At the lower end of the sluice he placed a rocker, and for one day manipulated the dirt that came down to it. At the end of the day he found that the rocker had saved scarcely any gold. Going along up the sluice, he found behind each of the cleats numerous sparkling particles of gold that had lodged there. He abandoned the use of the rocker, increased the number of cleats, and then commenced what he said was the first sluice mining ever carried on in California and probably in the world, so far as he knows. The sluice and riffles soon became popular, causing the price of lumber to advance rapidly. The Colonel says the only thing he regrets about his discovery is that he did not have it patented, and thus win fame and fortune.—*Nevada Transcript.*

DETECTION OF ERGOT IN FLOUR.—The suspected sample is treated with cold ether or boiling alcohol to dissolve the greater part of the coloring matters of the flour. The residue is then extracted with ether, mixed with a small quantity of sulphuric acid, and the extract is examined with the spectroscope. The ethereal extract of ergot, if concentrated, absorbs all the refrangible portion of the spectrum beyond D; if the solution is diluted, the spectrum is enlarged, and there appear three absorption bands: the first between D and E, wave length 538; the second between E and F, wave length 499; and the third between F and G, wave length 467.

[Continued from Supplement 279, page 4447.]

SIMPLE HOLTZ ELECTRICAL MACHINE.—CURATIVE APPLICATIONS OF STATIC ELECTRICITY.

By Geo. M. Hopkins.

Taken in connection with the articles in Supplements 278 and 279, the accompanying working drawings of a 12 inch Holtz electrical machine will be clear, and as all of the dimensions are marked on the drawing it will be unnecessary to go over the entire description in detail. Figure 1 is a front elevation, and figure 2 is a plan view. Of course these dimensions need not be adhered to, but the proportions may be followed for machines larger or smaller than the one represented.

After what has already been said in regard to the construction of the Holtz machine the reader will have very little difficulty in understanding the double-plate machine shown in the annexed engraving, Fig. 8, which is a plan view giving only such parts as are necessary to convey an idea of the construction. In this view the parts described in connection with the single plate machine are designated by the same letters of reference.

In this case as well as in the case of the single-plate machine, I have dispensed with apertures in the glass; possibly at the expense of simplicity; however, there is a point gained if the holes can be avoided. In the present case I mount the revolving disk, B, in precisely the same manner as shown in Figures 1 and 2, but the apertured disk, A, is placed in front of the disk instead of behind it, and in front of the fixed plate is the second revolving plate, K, which is supported by a shaft, N, having its bearing in the tube, M, supported by the post, L, from the base of the machine.

An elastic rubber ring is placed between the centers of the plates and serves to communicate motion from the plate, B, to the plate, K. The required pressure on the rubber ring between the two plates is secured by turning a screw, O, in the end of the tube, M. By means of this arrangement the added plate is carried by the rubber ring when the machine is turned.

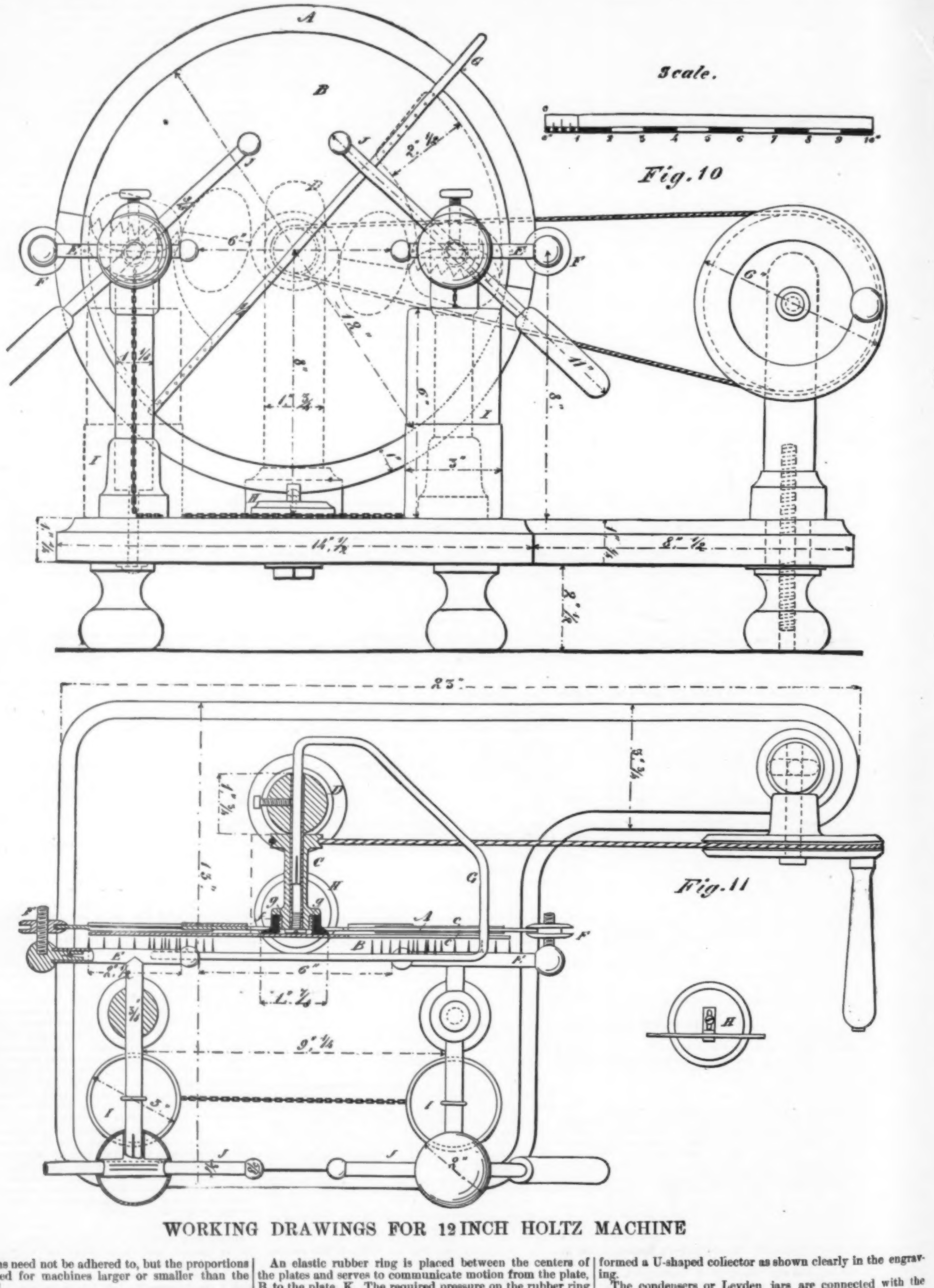
The combs, E, in this case are made double, as indicated in the engraving, the tube of which the comb is formed being bent into a U shape, and the points being inserted in the manner previously described. The central fixed plate is supported by blocks fitted to the bends of the combs. It is placed from one-eighth to three-sixteenths of an inch from each revolving plate, and its gilt paper teeth project straight down in the center of the space between the revolving plates.

For the sake of clearness only one double comb is shown in the engraving, and only one side of the cross arm, P, appears; both sides of the machine are alike in construction, the only difference being in the opposite arrangement of the parts. The cross arm, P, in the present case is supported in the middle by a shaft entering the rear end of the tube forming the support for the sleeve, and on each of its ends is formed a U-shaped collector as shown clearly in the engraving.

The condensers or Leyden jars are connected with the collecting combs or their support. Either one or two jars may be used on each side of the machine.

The machine is charged in the same manner as the single-plate machine, but the space between the plates being small, a thin piece of vulcanite will be required to charge it, as it must necessarily be inserted between one of the inductors and one of the revolving plates.

The spark from this machine will be no longer than that



WORKING DRAWINGS FOR 12 INCH HOLTZ MACHINE

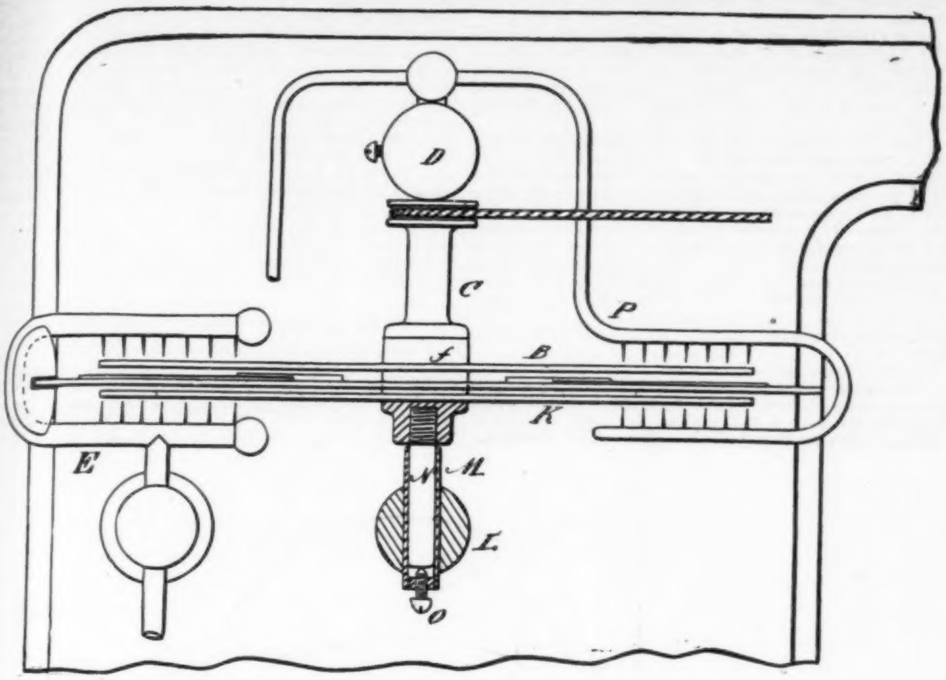
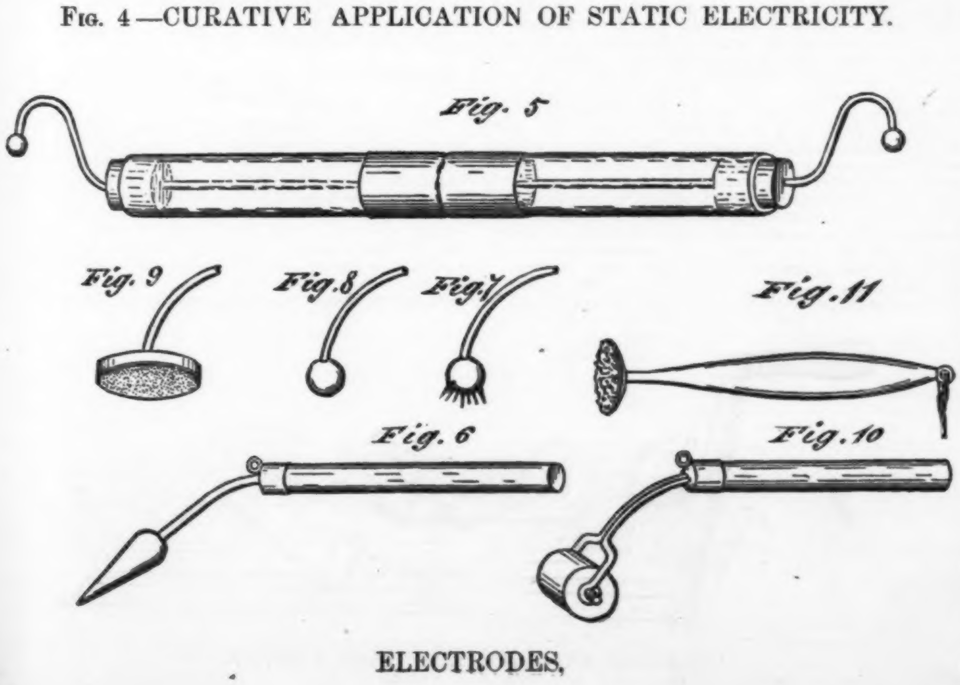


FIG. 3.—DOUBLE PLATE HOLTZ MACHINE.

FIG. 4—CURATIVE APPLICATION OF STATIC ELECTRICITY.



ELECTRODES,

of the single plate machine, but it will be "fatter," *i. e.*, the quantity of electricity generated will be greater.

Should it be found desirable to perforate the revolving plates so as to place them on a single support or shaft, it may be proceeded with in the following way: A hole of about the size required in the glass is cut in a piece of board, and the latter is placed over the glass plate and held by weights. A copper or brass tube of about the size of the hole to be drilled is attached to a bow drill, breast drill, or bitstock, so that it may be revolved, and as it is revolved in the hole in the board, and in contact with the glass it is supplied with rather coarse emery and water. A little patience and a considerable care as the hole is nearly through, are all that is required to complete the job. Where one has a lathe the hole may be easily made with a corundum wheel of small diameter, revolved against the center of the glass and supplied with water. A sharp file, wet with turpentine, will speedily enlarge the hole to the required dimensions.

For curative applications of static electricity a double plate machine seems to be an absolute necessity, and one with four or more revolving plates is more effective than the simpler forms of machine, for, according to Dr. W. J. Morton, of New York city, a certain quantity is essential to success; intensity alone is insufficient. I have lately examined some very effective machines having four revolving plates, and constructed especially for the treatment of diseases, by Messrs. J. H. Berge & Co., 191 Greenwich street, New York city. These machines are furnished with electrodes of different forms for administering the current in different ways. The machines give currents that cannot be distinguished from the faradic by sensation experienced or by the effects produced. In addition to this they produce powerful shocks and other effects that are quite beyond the capabilities of ordinary battery appliances.

As before mentioned, a machine having at least two revolving plates will be required to produce any beneficial effects.

Fig. 4 shows a method by which one may apply the electric current to himself, but it will doubtless be more convenient to have two assistants—one to turn the machine, the other to apply the electrode.

Fig. 5 shows a form of small double Leyden jar used in several sizes in connection with the machine for the purpose of condensing a limited amount of electricity in the machine. These jars are placed end to end, and lined and coated on the outside in the usual way. The curved rods are pointed on their inner ends, and extend nearly to the bottoms of the jars. The hooked ends of these rods are placed on the horizontal rods that support the collecting combs. The larger jars are removed, and the discharge rods are adjusted at a greater or less distance apart, according to the requirements of the case.

The patient sits in a chair upon an insulated platform, or as in the present case, with the legs of his chair in tumblers, which act as insulators. A board placed between the lower chair rounds forms a support for the feet, and is connected by a chain with one of the electrodes of the machine. By turning the machine one may charge himself with electricity, and if it is desired to treat any particular part, one of the electrodes shown in Figures 6 to 11 will be used, the glass insulating handle being grasped by the hand and the metallic portion connected with the gas fixture or floor, or otherwise connected with the ground, when the machine is turned and the electrode is presented to any portion of the body, sparks will leap from the body to the electrode.

The different forms of electrode are for producing different effects. Fig. 7 represents a pointed electrode made of either wood or metal, for drawing sparks from a local surface. Fig. 7 shows a ball with points. for drawing the charge silently. Fig. 8 is a plain ball. Fig. 9 shows a wooden disk coated with metal filings and covered with cloth. Fig. 10 is a rolling electrode, and Fig. 11 shows a sponge electrode, such as is used in connection with faradic machines. The current adapted to this latter form of electrode is an induction current obtained from the outer coatings of the condensers. The method of controlling and utilizing the static induction current is the discovery of Dr. Morton.

Many other forms of electrode are used in connection with the machine, and insulated tables capable of supporting several patients at once are employed by physicians who have adopted "Franklinism" for the treatment of diseases.

ELECTRICITY IN THE CARD-ROOM.

OF all the cares and trials of a carder's life, says the *National Record*, perhaps the one most mortifying is this electrical phenomenon. To enter the card-room on a clear, dry, frosty morning in winter, or in the spring when a dry cutting wind is blowing, and see the fibers sticking and flying hither and thither, with "ends" out more or less on every condenser in the room, and apparently impossible to ever again get them to keep in place, is, to say the least, a tantalizing affair. Carders are not supposed to know a great deal about electricity, and generally the extent of their knowledge of it consists in sprinkling water on the rubs, or allowing steam to escape from a pipe provided for the purpose, and knowing that the effect is remedial for the time being. Why such an effect takes place, or the wherefore of this invisible demon of electricity, are alike subjects utterly beyond their ken. If it was a thing that could be fixed with a wrench, or even if it could be seen, then they could tackle it; but as it is, it proves a veritable imp of darkness and mischief.

It may be remarked that, so far as we know, it is in America only that carders have this trouble; and it is owing to the dry climate that such is the case, and not a peculiarity of the wool, as many suppose. In Europe they rarely or never see any manifestations of it in their mills, and we remember a story of an American gentleman who had lived on the borders of one of the New York lakes, where electrical conditions of the atmosphere were so strong that it was easy by rubbing the foot on the carpet of a room to draw a spark from the fingers sufficient to light a gas jet. He being on the continent, related this to some friends, who doubted the story, and he declared it was the easiest thing in the world, as he would show them; but judge of his surprise, when the gas refused to light in spite of his vigorous rubbing, much to the amusement of his friends. Electricians have often to keep heated irons around their apparatus when conducting their experiments in Europe, on account of the humidity of the atmosphere; for there is no greater obstacle than dampness to the exhibition of electrical effects.

We shall try to explain the fundamental phenomenon of electricity, and we hope to make it plain enough to be better understood in regard to its application in carding.

If a tube of glass be made very dry, and then rubbed with a dry silk handkerchief, the tube will have acquired the

property of attracting small bits of paper, straw, and the like; the vigor with which they will be attracted and repelled depending on the amount of friction to which the tube has been subjected. The tube has then become charged with what is termed electricity, and we say it has become electrified. Only that portion of the tube, however, to which the friction has been applied possesses this power of attraction; it has not diffused itself throughout the tube, therefore it (glass) is termed a non-conductor of electricity.

If we take a metal bar, say iron, and subject it to friction while being held in the hand, it will not be so effected, because, the human body being a good conductor as well as the iron bar, the electricity will pass through the body into the earth. But if the bar is held in a tube of glass, and then rubbed, the phenomenon will be manifested, because it is then insulated through the non-conductibility of the glass. The electricity will, however, have diffused itself throughout the bar, and it will be manifested at the opposite end to that subjected to the friction. Therefore is iron termed a conductor of electricity.

If a list of, say thirty, of the worst conductors were arranged in succession, in proportion to their lack of conducting power, then wool would come about in the middle of the list—after silk, which is a worse conductor than wool. Non-conductors are often termed insulators, and air, when very dry, is an excellent insulator; dampness, however, changing it into a conductor, as before explained. This shows us plainly why, in damp weather, we have no trouble in the card room with electricity, it is conveyed away by the atmosphere as fast as produced.

A dry, cold atmosphere is in the best form as an insulator or non-conductor; therefore do we on such days have trouble with the slubbings flying every way, clinging to the iron framework of the machinery, or to the person, when near enough, or any other conductor of the electric fluid.

It is clearly evident, from the foregoing, that it is static electricity, or that kind produced by friction, to be more plain, which is the source of difficulty, and from this it follows that the radical cure is to reduce the friction and moisten the atmosphere.

So long as the wool remains in a more or less bulky form, the phenomenon is not manifested, nor does it have to undergo such excessive friction until it is brought in contact with the rubs of the condenser, when, being at the same time divided into numerous fine filaments, it becomes overpowered by the electrical influence.

Another reason why the generating power becomes accelerated in cold weather arises from the fact that the oil is to a certain extent congealed in, and fails to effectually lubricate, the wool fibers; that the greasy rub rolls are dry and rough, in the best condition for producing increased friction. The wool is also less elastic, supple, and altogether more liable to be excited by peculiar electrical conditions of the atmosphere in cold than in warm weather. These causes combine to give the carder much annoyance, unless they are well understood and the remedy intelligently applied. From the nature of the material worked and the influences pointed out, it must be evident that the only remedy is to reduce all friction to a minimum, and so remove the exciting cause. It has often been observed that, to sprinkle a little oil or water on the condenser rubs, even when the rovings are flying off in every direction, the trouble ends at once; but this is only temporary in its effects, which proves our position, that friction is the generating cause; for although, in lubricating or dampening the rubs with either oil or water, there is temporary relief, it only lasts until the water has evaporated, or the oil has passed off with the rovings, when it returns as bad as ever, because the friction is then increased to the same point as before the counteracting agents were applied.

When, therefore, the electricity begins to annoy you, I would advise the following plan: Take out all the rub rolls and scrape off the grease from each, afterwards rubbing with a clean oily rag to smoothness any roughness. Replace when clean and smooth, and set them apart one sixteenth of an inch, or at any rate so as not to touch in any part. Use a gauge, and set each end of each pair alike, commencing with the small stripper or wiper.

The roving does not require as much rubbing in cold as in warm weather, and the less it is rubbed the better, provided it comes off the spools well in spinning. Sprinkle a little oil on the side drawings, at the finisher feed rolls, previous to starting up, afterwards treating the rubs as described, which will in passing through further smooth them of any roughness that may have arisen from the scraping.

The trouble can also, in some cases, be immediately stopped by shortening the stroke of the eccentrics; but neither of these plans will entirely remedy the evil when considerable grease has accumulated on the rubs; the only thing to do in that case is to thoroughly cleanse them and make a new beginning. There is no need to go to extremes in setting them apart, so as to leave the rovings soft and flabby; the idea is to simply roll the rovings between the rubs without pressure, and this is all that is necessary under any conditions.

It may as well be stated here that the rubs are not intended to remedy defective carding, by attempting to rub inequalities out of uneven roving; they are there for the sole purpose of giving sufficient consistency to fine threads of wool, to enable them the more readily to unwind from each other in the spinning process; and all additional rubbing is unnecessary and mischievous. As a guide to others, the writer will mention that he has carded the finest quality of merino wool for fine flannels, etc., in a room where for days together the temperature was not higher than 38° F., and this was done without any device for neutralizing electricity, as none manifested itself. Any one can do the same, in any kind of weather, by making intelligent use of the hints here given.

Among the devices which have been tried as agents for neutralizing card room electricity, we may mention, that fine wire has been wrapped around the front condenser roll, wire of copper, of brass, tinned wire, iron wire, copper plated steel wire and annealed wire; and sometimes both front rolls have been covered. Rolls have been tried made of zinc, tin, copper, wood, glass, and hollow iron rolls, containing steam. Copper rolls set in front of the ordinary rubs are often employed, and are heated with steam; sometimes they are perforated, and are both made to revolve and to remain stationary. Wires stretched across for the rovings to touch, and then run into vessels of water, have often been recommended; and we have seen a patented institution similar to a lightning conductor applied with as many points as there were slubbings and conducted with the metal conductor, which ran into water or into the ground. Steam pipes have been applied both to the rubs and independent of them, and to the feed rolls, breasts, and leaders in. The rubs have also been coated with various substances, as flour, ashes, and the like; so that there is no lack of devices to select from, and, what is better, they are all sure cures, at once and for ever, etc., etc.

As an example of one of the above stated forms we will relate the contents of a letter, which gives a sure cure for electricity, as found in America, and then for comparison, another cure for the evil as found in Germany, which is also taken from a letter. The American letter instructs as follows:

"Take two wooden strips and tack them to the finisher frame, three inches from the rub roll, one on each side, and saw two slots in just opposite roving. Then take two bars out of the loom harness, place them in the slots on the under side of both top and bottom roving, letting the roving just touch them. Take a common small wire and loop it around each bar at one side of the card frame; let the wire be within one inch of the roving; let the lower end of the wire be six or eight inches long; lay a piece of iron on the card frame, bend the end of the wire so that it will be within one-eighth of an inch of the piece of iron, and you will have but little trouble with electricity. Carders, try it once."—*Industrial Record, N. Y.*

In Germany they go about it thus:

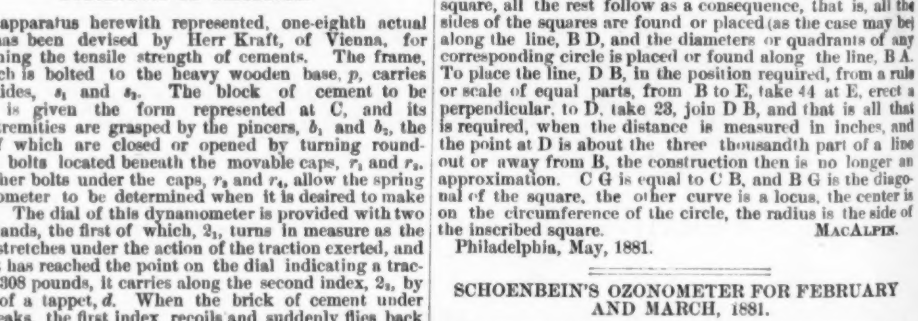
"The manufacturer in question found that during the process of carding his wool had got so electrified that it would not follow the narrow straps which in many continental condensers take the thread off the doffer. After careful observations it was found that the cause lay in the material used for greasing the wool. When the oil was mixed with water and spirits of ammonia it became perceptibly electric, especially with each change of the weather, and became such a nuisance that the spinning operation was seriously inconvenienced. This, however, only occurred with fine wool, which had been shorn unwashed, and then had been washed in a soda bath. Since the ammonia had been replaced by soda the inconvenience has almost disappeared, and it is only felt with great changes of weather."—*Deutsche Wollengewerbe.*

"Our contemporary states the facts, but does not offer an explanation. That electricity was generated through the application of ammonia cannot be disputed, and the cause of the phenomenon evidently lies here."—*Textile Manufacturer.*

It is a true old saying that "too many cooks spoil the broth."

APPARATUS FOR TESTING THE TENSILE STRENGTH OF CEMENTS.

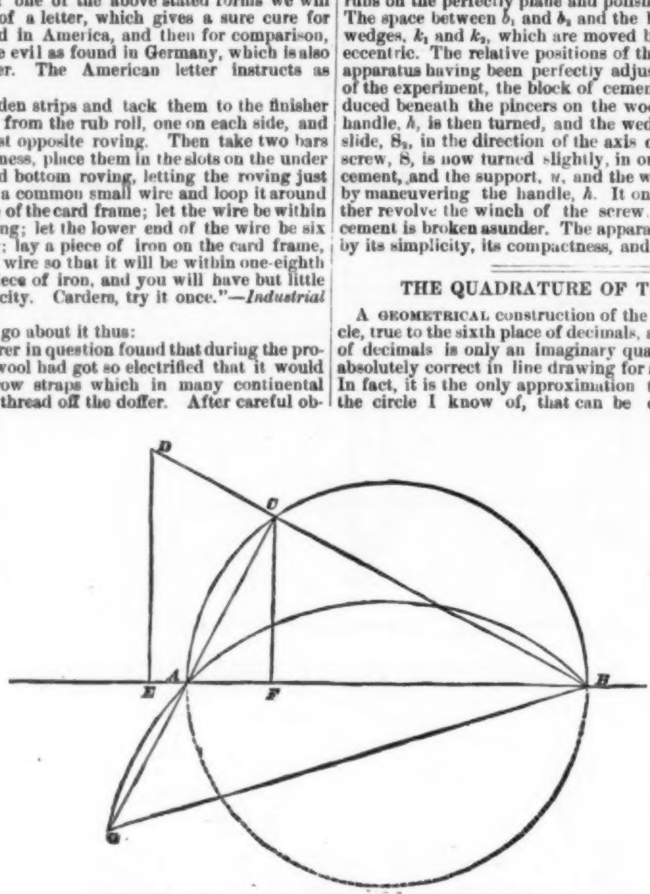
THE apparatus herewith represented, one-eighth actual size, has been devised by Herr Kraft, of Vienna, for acertaining the tensile strength of cements. The frame, B, which is bolted to the heavy wooden base, *p*, carries two slides, s_1 and s_2. The block of cement to be tested is given the form represented at C, and its two extremities are grasped by the pincers, b_1 and b_2, the jaws of which are closed or opened by turning round-headed bolts located beneath the movable caps, r_1 and r_2. Two other bolts under the caps, r_3 and r_4, allow the spring dynamometer to be determined when it is desired to make a trial. The dial of this dynamometer is provided with two index hands, the first of which, 2_1, turns in measure as the spring stretches under the action of the traction exerted, and when it has reached the point on the dial indicating a traction of 308 pounds, it carries along the second index, 2_2, by means of a tappet, *d*. When the brick of cement under trial breaks, the first index recoils and suddenly flies back to its initial position, while the other remains at the point which it had reached at the moment the rupture took place, and it is then easy to read on the dial the power that was exerted to sunder the cement. The slides are moved by turning the winch with which the screw S, is provided. In order that the indications given by the apparatus as thus constructed be exact, the divisions in the dial must be absolutely equal, the tensile force must be exerted in the direction of the axis, and consequently the block must be placed in the axis of the apparatus, and, finally, the force exerted on the block must be transmitted integrally to the slide, S_2. To realize these different conditions the slide, S_1, is provided with a rounded groove which serves to guide it, and the slide, S_2, runs on the perfectly plane and polished sides of the frame. The space between b_1 and b_2 and the base may be filled with wedges, k_1 and k_2, which are moved by the handle, *h*, of an eccentric. The relative positions of the different parts of the apparatus having been perfectly adjusted at the beginning of the experiment, the block of cement to be tested is introduced beneath the pincers on the wooden support, *u*. The handle, *h*, is then turned, and the wedges at once place the slide, S_2, in the direction of the axis of the apparatus. The screw, S, is now turned slightly, in order to fix the block of cement, and the support, *u*, and the wedges, *k*, are removed by maneuvering the handle, *h*. It only remains then to further revolve the winch of the screw S, until the block of cement is broken asunder. The apparatus recommends itself by its simplicity, its compactness, and its effectiveness.



TESTING INSTRUMENT FOR CEMENT.

THE QUADRATURE OF THE CIRCLE.

A GEOMETRICAL construction of the quadrature of the circle, true to the sixth place of decimals, as a 3 in the sixth place of decimals is only an imaginary quantity, it is therefore absolutely correct in line drawing for all practical purposes. In fact, it is the only approximation to the quadrature of the circle I know of, that can be of any use whatever to the practical workman, who has no more knowledge of arithmetic or figures than just to be able to read the number of inches on his foot rule. Schofield says in an article on the quadrature, in a book published over 50 years ago, if a straight line could be drawn equal to the quadrant of a circle, the quadrature would then be no longer a paradox.



QUADRATURE OF THE CIRCLE.

The novelty claimed in this discovery is, that it is obtained from whole numbers, and is neither haphazard, nor rule of thumb, as the proof is self-evident. The rule in mensuration from which this quadrature is obtained is, that ¼ part of the circumference, multiplied by the diameter, is equal to the area of the circle. The problem in geometry, which, of course, is infallible, is, that if the line, B F, by construction, is made equal to ¼ part of the circumference of a circle of which A B is the diameter, and the line, F C, is perpendicular to it, the line or chord, C B, is the side of a square equal in area to the same circle.

Therefore, all that is necessary to constitute the quadrature of the circle, is simply to place the line, D B, in the position or angle required, to the diameter or line, A B, and when any single measurement is given in either a circle or a square, all the rest follow as a consequence, that is, all the sides of the squares are found or placed (as the case may be) along the line, B D, and the diameters or quadrants of any corresponding circle is placed or found along the line, B A. To place the line, D B, in the position required, from a rule or scale of equal parts, from B to E, take 44 at E, erect a perpendicular, to D, take 23, join D B, and that is all that is required, when the distance is measured in inches, and the point at D is about the three thousandth part of a line out or away from B, the construction then is no longer an approximation. C G is equal to C B, and B G is the diagonal of the square, the other curve is a locus, the center is on the circumference of the circle, the radius is the side of the inscribed square. MACALPIN.

Philadelphia, May, 1881.

SCHOENBEIN'S OZONOMETER FOR FEBRUARY AND MARCH, 1881.

THE curve of coloration for February shows an approximate coincidence of the color curve with the storm curve, but succeeding it in time, the synchrony appearing with exaggerated force on Feb. 28. The marked exception lies in the portions extending over the 5th, 6th, and 7th, where the high readings, alternating with low points, are not visibly connected with any atmospheric disturbances, the line of clear weather running uninterruptedly through this period. The changes of temperature seem to have influenced the test papers during these days, the deep tints appearing with the recurrence of warmer weather. On the morning

of the 5th of February the thermometer indicated 10° Fah., which rapidly changed to 35° Fah. at noon. A similar change followed on the 6th and 7th, but the decline on the night of the 8th accompanied no such contrasted temperatures, both day and night being warm. It may be conceded that the coloration was heightened by moisture at every recurrent rise of temperature.

The threatening weather from the 9th to the 11th was coincident with storms westward, and the color curve reached its maximum for the month, doubtless influenced by the fog prevalent at that time.

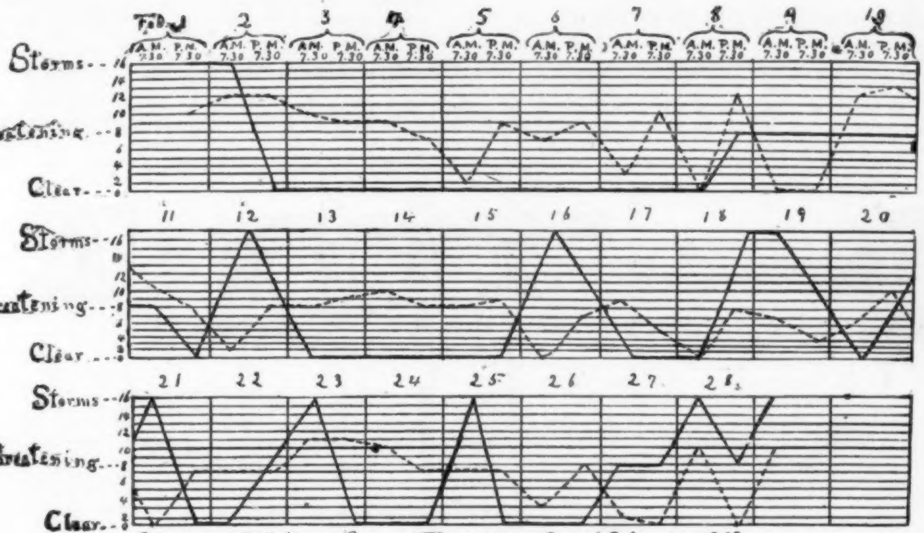
The storm of the 12th, an easterly rain storm, was followed by clearing west winds and colder weather, and the color curve is maintained at 8 until the advent of the storm on the 15th and 16th, when it sinks to 0 and then rises with the weather curve.

Similar perturbations follow the stormy weather of the 16th and of the 18th and 19th, but it anticipates the weather ascension on the 20th, falling to 0 on the 21st, and again maintaining itself to the 26th through the influence of the stormy weather of the 23d and 25th, and the intermediate presence of a cold wave on the night of the 23d.

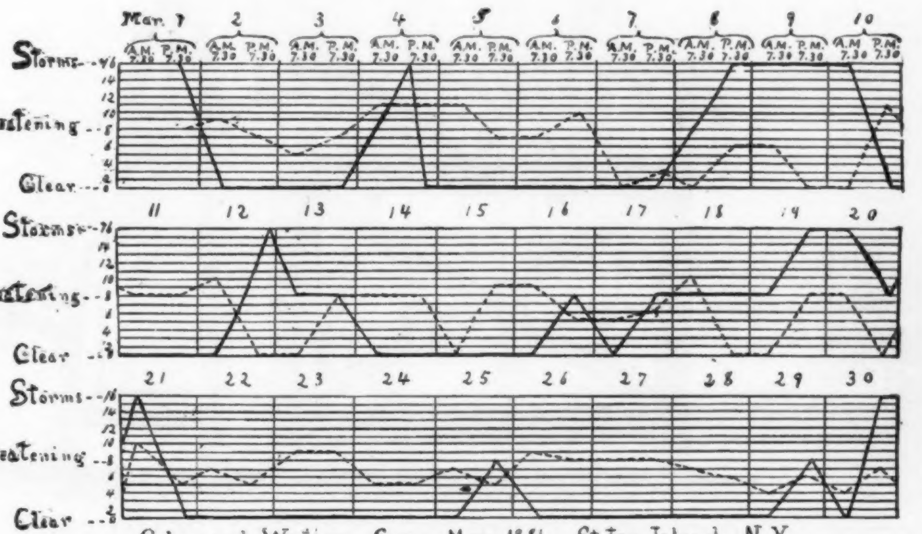
For March the same general coincidence strikes the eye, a succession of crests in each curve, occurring either nearly or quite together. When the color line rises elsewhere, as on the 15th and 16th, the 23d, 26th, and 27th, it seems due to wind, or at least on those days the wind was fresh and strong, of the unal, does not admit of a doubt, but is a matter of fact and of truth. For it would seem to be a self-evident proposition that the first natural division of the unal is into halves, the second into quarters, the third into eighths. Consequently, the first natural scale of numbers is the dual or line scale; the second is the duo dual or surface scale; the third is the cubal or solid scale.

To illustrate: Take the line number, three, and cube it, and we find it is written 27 on the decimal scale. Now take the number six, and we find it is written 216. Now take twelve, and it is 1,728. Now twenty-four, and we find it to be 13,824. Now let us see how these same numbers stand on the natural scale of cubes. The number three, cubed, would be written 33. The number six, would be 330. The number twelve, would be 3.300. The number twenty-four, would be 33,000. Consequently, the conclusion seems inevitable, that all line numbers should be written on a line scale, all surface numbers on a surface scale, and cube or solid numbers on a cubal or solid scale.

The line number, three, written on a line scale would be 11. This number squared and put on a surface scale would be 21; same number cubed on a cube scale would be 33. Two feet in a perfect square. In presenting to you, to-day, 288 inches, or two square feet in a perfect square, I wish it to be distinctly understood that there are no pluses to be subtracted or minuses to be added, for if there was a small plus you might look for it in the center; on the contrary, you



Color and Weather Curve. Feb. 1881. Staten Island. N.Y.
—— Weather Curve. ---- Color Curve.



Color and Weather Curve. Mar. 1881 Staten Island. N.Y.
—— Weather Curve. ---- Color Curve.

SCHOENBEIN'S OZONOMETER.

Dr. Bauer, in 1877, showed the hygrometrical value of these papers, and though their color generally deepens, under conditions of humidity, some marked exceptions occur.

In April thallious hydrate tests and tests over water will be made.

L. P. GRATACAP.

77th Street and 8th Avenue.

THE NEW SYSTEM OF MATHEMATICS.*

MATHEMATICS, like astronomy, was one of the first of the sciences to be investigated, and, also, like astronomy, it is, as yet, but imperfectly understood. And however much we may admire the genius, the intellect, the wisdom of those great mathematicians of antiquity, Pythagoras, Euclid, and Archimedes, the truth is it were an impossibility for one man, or one era of great men to have measured the length, the breadth, the depth of this the science of sciences—this science without which the universe itself were an impossibility.

In confirmation of the position I have here taken, I have to say that the very basis of a true system of mathematics is the discovery of the natural scale of numbers.

Just when, where, or why, in the remote past, the so-called decimal system was first adopted is a matter of doubt and of speculation. But that the decem is an unnatural and of aggregation of unals, as the decimal is an unnatural division

*Paper read by Eli Baldwin at the Union Meeting of the Mahoning and Trumbull Teachers' Association, held at Niles, Ohio, April 30, 1881.

will see that the center is a mathematical point. Or if there was a small minus, you might look for it in one of the four corners; on the contrary, you will see the corners are all full. It is not my purpose to-day to give you the length of the line of the square, although it can be given exactly, and will be at some future time.

UNINFLAMMABLE FABRICS.

To the Editor of the Scientific American:

I see by your SUPPLEMENT, page 4221 (January 29, 1881), you publish an item, "That the French Society for the Encouragement of National Industry have awarded to M. Martin, of Paris, a prize of 1,000 francs for his preparation rendering textile fabrics uninflammable." It is announced as a *new discovery;* and, as I am not willing the credit should go to France, when the United States is entitled to it, I would respectfully call your attention to the fact that the same was patented on the application of my brother, James H. Johnson, M.D., as early as 1850, and the patent granted to me as his administrator by our government, under date September 26, 1850.

Owing to the death of my brother its manufacturing was abandoned, and nothing done with it since.

Galena, Ill., 1881. M. Y. JOHNSON.

The Johnson patent referred to by our correspondent, granted September, 26 1850, was for rendering cordage uninflammable. The following is the process as described in the specification of the patent:

"In a vat I place water and saturate it with any of the neutral salts or alkaline preparations by heating it with peroxide of manganese, muriate of soda, and sulphuric acid, in the proportions ordinarily used for generating chlorine, and when the chlorine ceases to come off from the saturated watery solution I then immerse the cordage and allow it to remain for a sufficiently long time to be perfectly saturated with the salts contained in the solution; it is then taken out and dried, when it is found to be uninflammable. To preserve this uninflammable condition the cordage is placed in a vat containing a solution of bichloride of mercury, to which is added a sufficient quantity of gelatinous matter to render it about the consistency of cream or thin varnish; after being thoroughly saturated with this solution the cordage is removed and dried.'

THE DENSITY AND TENSION OF SATURATED VAPORS.

IN a recent number of the *Annalen der Physik*, Herrn. Wüllner and Grotrian have described a careful investigation of the density and tension of saturated vapors, which they have carried out by well tested methods on the vapors of sulphide of carbon, chloroform, sulphuric ether, water, and acetone. In the introduction to their paper they give an account of the state of the question, and a brief summary of the results they have arrived at. The scope of their statement is as follows:

"Past experiments with regard to the density of saturated vapors have, with exception of Fairbairn and Tate, given values which little agree with those deduced, according to the mechanical theory of heat from Regnault's observations. The experiments of Herr Herwig, especially, give a considerably higher value for vapor-density than the theory, and also, for most liquids, a different increase of vapor-density with rising temperature. In the case of sulphide of carbon the ratio between the vapor-density calculated from the relation given by M. Herwig, and that obtained by theory, is nearly constant (the one is always about 4 per cent. greater than the other); but, on the other hand, for water and chloroform, the vapor-density increases considerably faster; for chloroform, *e.g.*, the ratio at 30° C., is equal to 1·043, at 100° it is 1·112. For water also at 100°, the ratio of the vapor-densities is already 1·111, whereas, at 11°, the vapor falls on Mariotte's law.

"Against the accuracy of the numbers got by Fairbairn and Tate, various objections based on the arrangement of the apparatus may be brought, and especially an exact determination of temperature is rendered very difficult.

"Herr Herwig's experiments have followed the density of the saturated vapors only to about atmospheric pressure, as the apparatus he used did not allow of compressing the vapor much more. He has thus left it doubtful whether the relation established by him holds good also for higher temperatures. In these experiments, too, a difficulty in determining the density of the saturated vapors appeared, in that the vapors, at least in part, were precipitated on the walls of the vessel before they showed the constant maximum tension. The precipitation should decrease with rising temperature. So that Herr Herwig assumes that, at higher temperatures, condensation of the vapor first occurs when maximum tension is reached.

"The question as to the density of saturated vapors is thus not settled experimentally, and we have, therefore, taken it up again, and sought to determine the vapor-densities for a series of liquids up to a pressure of about three atmospheres. In this research it became necessary to consider whether the premature condensation observed by Herr Herwig were to be attributed to an adhesion of the vapor to the walls. As it must be operative even before the deposit becomes visible, the density of the vapor must thereby come to be found too great. If we would ascribe the difference between Herr Herwig's values and those of theory to such an adhesion of the vapor, then the determination of the vapor-density in vessels of different size must yield different results, the density must be the less the larger the vessel. For the larger the wall-surface in proportion to the cubical capacity of the vessel, the greater must the fraction of vapor adhering to the wall be. The vapor densities were, therefore, first determined in three spherical balloons, whose volumes were nearly as 1 : 2 : 4, and the inner wall surfaces, therefore, as 1 : 1·587 : 2·520. That with differences such as Herr Herwig got for vapor densities, as compared with theory, the ratios now given are sufficient for decision of the question can be easily shown. . . . The determinations of the specific volume of saturated vapors given in the first part of this work show no such influence of adhesion to the walls; they seem to prove that the specific volume of vapor is independent of the size of the space in which it is determined.

"On the other hand, the measurements confirm the result obtained by Herr Herwig, that vapors are precipitated before they have reached the so called maximum tension. They further prove that the tension at which condensation begins, the tension of condensation, stands in a relation of the maximum tension which is dependent on the nature of the liquid, but nearly independent of the temperature. The measurements appear to yield the unexpected result, that in general there is not a maximum tension in the hitherto accepted sense, but rather that the tension of saturated vapors, even when they are in contact with a large and excessive quantity of liquid, considerably increases through compression. It would appear as if the intermediate state, assumed by J. Thomson, were approximately realized. Any view of the process of vaporization must, therefore, be somewhat modified." (For details of the author's research we must refer to the original paper.)

AURAL SYMPTOMS IN BRIGHT'S DISEASE.

CONTINUOUS or intermittent deafness has been described as a comparatively frequent concomitant of chronic nephritis by Rosenstein and Rayer. More recently Dieulafoy has called attention to such aural complications. Pain in the ears and tinnitus aurium have been added to the list of significant precursors of uræmia by these authors. A separate thesis was lately published by Pissot, entitled "*Les troubles auditifs dans le mal de Bright.*" Hitherto, however, the nature of aural complications in Bright's disease has been regarded rather in the light of functional disturbance than anatomical lesion.

Dr. Gurovitsch, of Odessa, records a case of parenchymatous nephritis where aural disease became a prominent complication, and where definite lesions were found. The case was that of a soldier, aged twenty-two, who had been a chronic sufferer from malarial affections. On his admission to hospital he had an intermittent fever of an irregular type. He complained of pain in the right ear and partial deafness. It was ascertained that he had parenchymatous nephritis

Soon a purulent otitis media was developed, and later the previously healthy left ear likewise became implicated. Facial œdema was superadded to the other symptoms, and this became more marked with the increased violence of the aural symptoms. When the latter showed an amelioration, the œdema also partially subsided. Gurovitsch is at a loss how to account for this coincidence. The patient died of pericardial dropsy and cardiac failure, and at the autopsy the aural lesions were found to correspond to the diagnosis of otitis media purulenta.—*Berl. klin. Woch.*

THE CHIME AT ST. GERMAIN L'AUXERROIS.

Formerly when church chimes were rung by hand, it was always effected by maneuvering the clappers inside the bells by the aid of pedals, and of keys arranged on a sort of key board.

The old automatic system consisted of a metallic cylinder covered with numerous projecting pins, and rotated by a clockwork movement. In revolving, this cylinder raised, by means of the pins on its surface, the levers, which were connected by wires with the clappers; and the latter, on falling back against the bells, produced the tones necessary to play the desired airs.

When it was desired to obtain very powerful tones and to play tunes of some length, an enormous power had to be expended. By the aid of the key board and its attachments it was necessary, in fact, to raise clappers, which in some cases were extremely heavy, and to overcome a resistance that could be surmounted only by great trouble, and that too by striking with the fists on the keys and with the feet on the pedals. (Fig. 1.) When this automatic cylinder was employed, it was necessary (owing to the fact that it had to raise heavy clappers) to give it dimensions varying day. Fig. 2 shows the chime as now definitely located in the tower of St. Germain l'Auxerrois.

In the old systems of chimes there was but one mechanism for all the bells, but in this each bell has a special set of motive wheels of a power proportioned to the weights. As each set of wheels can operate only when it is desired to obtain the sound of the bell connected with it, it uses its power only when it acts. The manufacturer has based his calculations of the motive weights on data from experiments which have shown that, in large bells giving the bass tones in the chimes, the effort necessary to raise the clappers is about equal to a hundredth of the weight of the bells; a bell of 4,000 pounds, for example, requiring an effort of 40 pounds. But in the small bells the effort is relatively greater in proportion to their weight, and may be estimated at about one-fifth; so that for a bell of 20 pounds, for instance, an effort of 4 pounds would be necessary. As may be seen, then, this division of the weights and sets of wheels affords considerable economy in motive power. This arrangement, moreover, has the advantage that the wheels operate with sufficient speed to allow passages to be readily played which contain quavers and semiquavers.

Finally, it may be remarked that one of the characteristic features of this chime is that the operations of the automatic cylinder are effected without any outside aid—the mechanism once wound up taking care of itself.

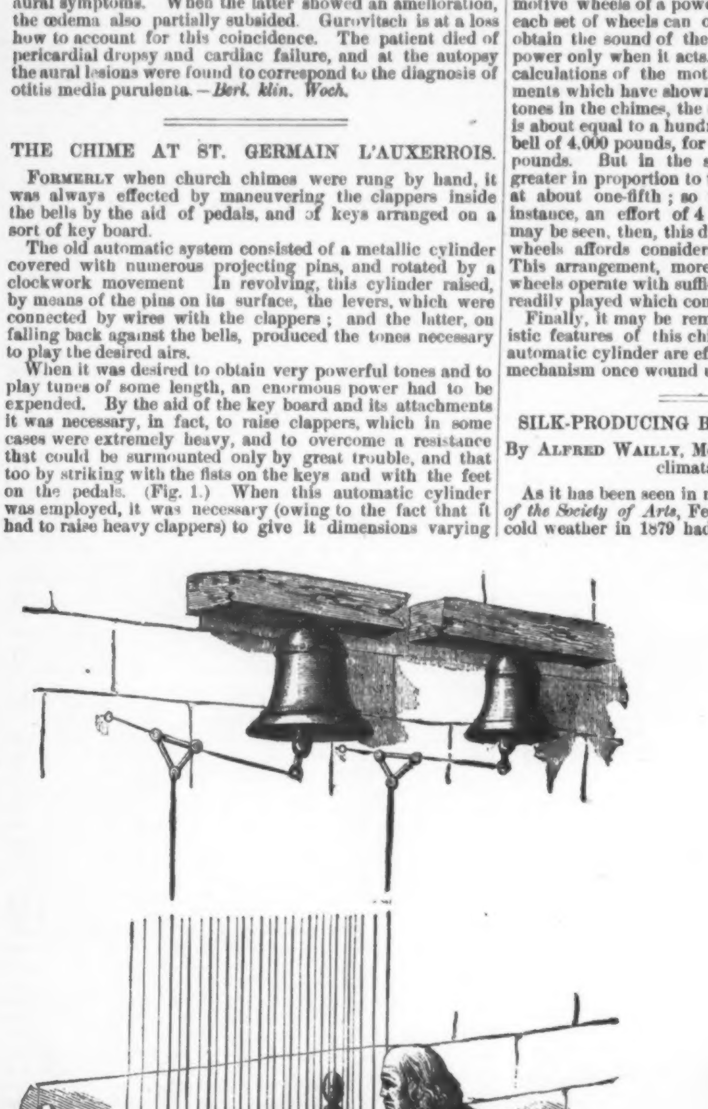


Fig. 1.—KEY-BOARD CHIME.—OLD SYSTEM.

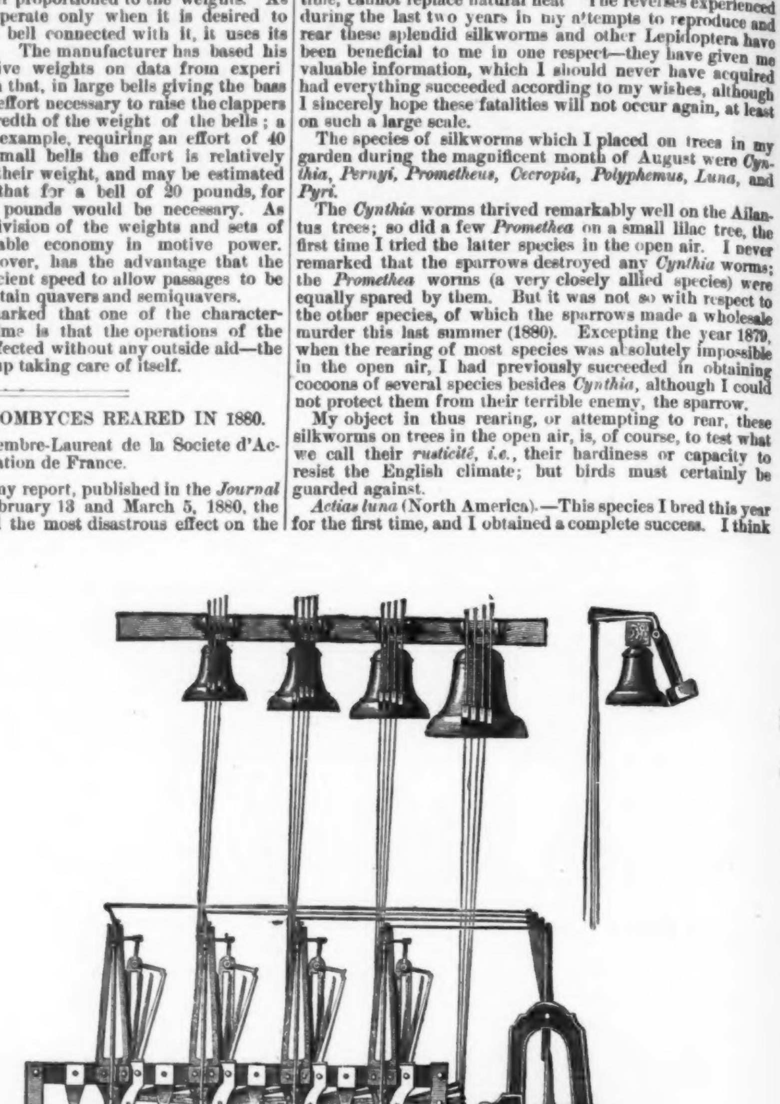


Fig. 2.—NEW CHIME OF SAINT GERMAIN L'AUXERROIS.

from 3½ to 6½ feet in diameter, and a very considerable rotary power. To actuate these machines, weights of from 1,000 to 6,000 pounds were employed. These were suspended from chains rolling around drums, and were wound up by means of windlasses, requiring the labor of from one to three men for one or two hours. The chime of the Samaritaine, at Paris (destroyed in 1813), was on this system. At Bruges, Belgium there is a very perfect chime of the same kind. It is provided with a bronze cylinder weighing no less than 22,000 pounds, and representing a value of $8,000 for the metal alone. These old-fashioned chimes, as may well be seen, were very costly and inconvenient. They utilized at the very most only 30 per cent., or at the least, one third of the force expended. This will be readily understood if it be taken into consideration that the cylinder, always revolving with the same speed, expends as much power to sound a 6-pound bell as to strike a large one weighing 6,000 pounds.

The chime recently placed in the Saint Germain l'Auxerrois, at Paris, differs essentially from those above described and marks a great progress in the manufacture of these apparatus. It consists essentially of: (1) sets of wheels and weights equal in number to that of the bells and of power proportionate to the weight of the latter; (2) of a key board similar to that of a piano and operated the same way; and (3) of a cylinder for playing automatically, of about 16 inches diameter, so arranged that it can be removed and replaced by others affording other tunes. The importance of the revolution effected in the mechanism may be realized when we state that this chime, instead of needing the labor of two or three men during a part of a day for winding it up, requires but the labor of one man for ten minutes each week to wind up the weights connected with the automatic part, which is arranged to play four airs per

SILK-PRODUCING BOMBYCES REARED IN 1880.

By Alfred Wailly, Membre-Laureat de la Societe d'Acclimatation de France.

As it has been seen in my report, published in the *Journal of the Society of Arts*, February 13 and March 5, 1880, the cold weather in 1879 had the most disastrous effect on the rearing of exotic Lepidoptera. In 1880, the fine and warm weather we had during the month of August and part of September allowed of the successful rearing of several species in the open air; but the cold and wet weather, lasting till about the end of July, had the same effect on most species, as in 1879. The moths of *S Promethea*, for instance, which generally emerge at the end of June and beginning of July, had not all emerged before the end of August; one, *S. Cynthia*, emerged on the 7th of September. Excepting a few, the Indian species did not emerge at all. Four *Actias selene* moths were obtained at intervals; the others remained in the pupa state. No pairing could be obtained. The same failure attended *Attacus mylitta* (Himalaya race), of which I only obtained nine moths, from the 18th of August to the 7th October, giving me no chance of obtaining fertile ova. A singular fact respecting *Attacus mylitta* is, that some cocoons placed in a hot house at a gardener's, in April, did not produce any moths till August, too late to rear this species, if fertile ova could have been obtained.

At the end of February, 1880, I received from Calcutta 900 cocoons of *Attacus mylitta* (Himalaya race), about 750 of which had died in transit, but none had emerged. Later on, April 19, I received from Major Coussmaker a tin box containing 100 *Mylitta* cocoons of the Bombay race, more than two-thirds of which had emerged on the way. The tin box had evidently been kept in too warm a place, and the metal had quickly communicated the heat to the cocoons. From the remaining cocoons of this Bombay race I obtained several fine moths, from the middle of May to the beginning of July, but, as with the Himalaya race, no pairings took place, the weather being too unfavorable. I had to keep them in a room.

For two years I have had a series of disasters, owing to various causes. The greatest difficulty is to obtain the cocoons alive from abroad; the next great difficulty is the struggle against the climate, which has been my greatest enemy here during the last two years. Artificial heat, unless pure air and a free ventilation can be obtained at the same time, cannot replace natural heat. The reverses experienced during the last two years in my attempts to reproduce and rear these splendid silkworms and other Lepidoptera have been beneficial to me in one respect—they have given me valuable information, which I should never have acquired had everything succeeded according to my wishes, although I sincerely hope these fatalities will not occur again, at least on such a large scale.

The species of silkworms which I placed on trees in my garden during the magnificent month of August were *Cynthia, Pernyi, Prometheus, Cecropia, Polyphemus, Luna,* and *Pyri*.

The *Cynthia* worms thrived remarkably well on the Ailantus trees; so did a few *Promethea* on a small lilac tree, the first time I tried the latter species in the open air. I never remarked that the sparrows destroyed any *Cynthia* worms; the *Promethea* worms (a very closely allied species) were equally spared by them. But it was not so with respect to the other species, of which the sparrows made a wholesale murder this last summer (1880). Excepting the year 1879, when the rearing of most species was absolutely impossible in the open air, I had previously succeeded in obtaining cocoons of several species besides *Cynthia*, although I could not protect them from their terrible enemy, the sparrow.

My object in thus rearing, or attempting to rear, these silkworms on trees in the open air, is, of course, to test what we call their *rusticité, i.e.*, their hardiness or capacity to resist the English climate; but birds must certainly be guarded against.

Actias luna (North America).—This species I bred this year for the first time, and I obtained a complete success. I think it is one of the easiest species to rear. The larvæ were fed on walnut, some of them being kept under large bell-glasses, till they formed their cocoons, which are of very thin texture. This species is of no value as a silk producer, and cannot be called a silkworm, but it is very beautiful; the perfect insect, like the Indian *Selene*, resembles a swallow-tail butterfly of a yellowish-green; it is smaller than *Selene*. Other *Luna* larvæ thrived equally well on a nut tree in my garden, with *Polyphemus* and *Cecropia*, but, as stated before, the sparrows destroyed them all, when in the third and fourth stage. I had a large quantity of *Luna* cocoons from America, and the moths emerged from the beginning till about the end of June. I obtained twelve or thirteen pairings. In the first two stages there is a striking difference between the larvæ of *Actias luna* and those of its Indian congener, *Selene*. *Selene* larvæ in the first stage are dark red, with a broad black band across the middle of the body, in the second stage, they are of a lighter red, without the black band; in the other stages they are green, like *Luna* larvæ. *Luna* larvæ are green in all their stages; in the first stage, of light or whitish green. When large, the tubercles on *Selene* larvæ are bright yellow, and on *Luna* larvæ, of various shades of red or crimson.

Attacus aurota (South America).—On the 5th of June, 1880, I received from French Guiana a box containing eighty-two cocoons of this splendid species (the South American *Atlas*), and eighteen smaller cocoons of a species called *Bombyx hesperus*. The latter had all been attacked by dipterous parasites. The cocoons of *Bombyx hesperus* are similar in shape and size to those of *Cynthia* (the *ailantus* silkworm), but they are of a much darker color. The moths of *Attacus aurota*, of a rich and silky brown, with a triangular window on each wing, are smaller than most of the various races of *Attacus atlas*. The *Aurota* cocoons, of a brilliant

golden or silvery silk, are open at one end, and similar in shape to those of *Atlas*. A certain number of the *Aurota* moths had emerged during the voyage, but the remaining live cocoons were in good condition, and produced, from the 12th of June to the 19th of August, splendid and perfect moths, which unfortunately refused to pair, the weather being too cold for this equatorial species. On the evening of the 2d and 3d of July, the weather being then very cold, a fire was lighted in a large room in which I had a number of cages containing *Aurota*, *Mylitta*, *Selene*, and other moths, but all to no purpose for these three species. At the Société d'Acclimatation, in Paris, they also failed to obtain pairings from the *Aurota* moths which had emerged from the cocoons I had sent to the secretary of that society.

Attacus aurota is found in Brazil, and very likely all over equatorial America. Various names are given to different races of *Aurota*, as if they were distinct species. *Attacus speculifer*, found in Brazil, is so much like the true type *Aurota*, that it seems but a variety, if it be even a variety. My own *Aurota* (Guiana race) is rather more like *Speculifer* than the one given as the true *Aurota*. All three, in my opinion, are one and the same species. The multiplicity of names is sometimes bewildering. At the British Museum, for instance, among the Indian species of the genus *Actias*, we find *Actias mænas* and *Actias leto*, side by side, it is true. Now these, according to an experienced American entomologist, Herman Strecker, are the same species: *leto* is the name given to the male, *mænas* that given to the female. The male is blotched all over with reddish brown, the female is plain green, at least such as I remember to have seen.

The *Aurota* I received has, every year, six generations in French Guiana. Such is the effect of equatorial heat on these insects, whose life is as ephemeral as it is active. How different from insects found in cold countries, which sometimes require three years to reach the perfect state! I have seen cocoons of Indian species, such as *Mylitta* and *Selene*, hybernate twice, and even three times, under the influence of the English climate.

To conclude this notice on *Aurota*, I will translate and quote a few passages from my French correspondent's letters: "In our French Guiana we have five distinct species of silkworms, but I only have time to rear two, which I do on a hedge in my garden. Our silk-producing larvæ, have regular, pacific habits, which make the rearing easy and attractive. The *Aurota* moths emerge one month after the formation of the cocoon; the pairings here take place in the open field, and the females lay over 600 eggs each; eight days after the larvæ hatch, and in twenty days the cocoon is formed. *Bombyx hesperus* forms its cocoon fifteen days after the hatching of the larvæ, and the same operations are renewed every sixty days for *Aurota*, and every fifty-two days for *Hesperus*. We can, therefore, produce six crops of cocoons every year, and these crops would have no other limit but the extent of the plantations, the foliage of which is renewed twice a year. So, you may think, how inexhaustible would be such a production of silk, if a European company seriously took this industry in hand. *Bombyx hesperus* and *Attacus aurota* live on the same trees, and both will live, I think, on the *Ailantus; Aurota* lives here also on the orange tree, and on the *Eucalyptus*."

Attacus atlas.—In 1879, Mr. P. H. Gosse, F.R.S., of Torquay, published a long and interesting memoir on *Attacus atlas*, in which a very minute description is given of the egg, the larva in its six ages, and then of the cocoon and pupa. Herr L. Huesmann, of Nienberg, in Hanover, has also written a memoir on *Atlas*, which has appeared in the *Isis*, of Berlin, on the 9th, 19th, and 23d of September, 1880.

In one of my reports on silk producers, I mentioned that, in the year 1878, I had a quantity of live cocoons of *Attacus atlas*, but the moths having commenced to emerge in the middle of July, when I was about to start for Paris, I was unable to rear this species. In 1879, I had no cocoons nor ova of *Atlas*, but, in 1880, a French correspondent sent me sixty five ova about the middle of August. The season being then too far advanced to give me any chance of rearing the larvæ here, I sent the ova to two correspondents on the Continent, keeping only twelve, to see when the larvæ would hatch, and how long they would live under a bell-glass. Both my correspondents failed to obtain any satisfactory results. One stated that the ova had not hatched, the other wrote to me that half of the eggs had not hatched, and that the larvæ obtained had all died in a very short time.

With my twelve ova, I obtained five larvæ, which hatched on August 22. Three died in first and second stage, but the other two, strong and healthy, were in splendid condition on the 6th November, when they were sent for preservation. The weather had become very cold, the foliage might have failed at any moment, and the larvæ were too far from the spinning period to give any chance of obtaining cocoons; they had been in the fifth stage from the 5th of October (thirty-two days), and showed no sign of entering into their last sleep previous to passing into the sixth and last stage. The larvæ were fed on a superior species of the common barberry (*Berberis vulgaris*), with large thick foliage. This food I found the best for them. The different stages took place as follows First stage commenced on the 22d August, the second on the 2d of September, the third on the 10th of September, the fourth on the 20th of September, the fifth on the 5th of October. The larvæ were five days in sleep before passing into the fifth stage, in which they remained as above stated—thirty-two days. Those bred in 1878, by Major Lendy, of Sunbury-on-Thames, were only one month from the time of hatching to the formation of the cocoon, but they were in a hot-house.

The larva of *Atlas*, when hatched, is black, with long, white, soft spines. In the subsequent ages, the larva appears almost entirely white; this is due to a white powder, which covers not only the tubercles but the greater part of the body, thus rendering a description of the larva rather difficult. In the second and third stages, the color seemed orange on the parts of the body from which no farina was excreted. The larva of *Attacus cynthia* (ailantus silkworm) is also covered—but not so thickly—with a white farina in its last stages. On removing the powder, the skin of the larvæ is green. Having only two atlas larvæ, I would not remove the powder, to see their color, as I feared to run the risk of injuring or killing them. As is the case with other species, there are six rows of spines on the larva, the two rows on the top of the back being the longest; the two lateral rows are very small, and almost filiform. The farina on the four top spines is so thick that they look as if covered with hoar frost. In the fifth stage, the larva seemed of a yellowish green, the tips of the spines blue; the anal segment, which is blue, with small black spots, has on each side an orange-red ring. This is a very short and imperfect description of the *Atlas* larva, but a complete one is found in Mr. P. H. Gosse's "Memoir on the Great Atlas Moth of Asia." From a letter just received, I hear that, in 1880, Mr. P. H. Gosse had a complete success in the rearing of *Atlas* larvæ, from ova received in June, the result being a number of fine cocoons.

Attacus pernyi (North China).—This most valuable oak silkworm, now thoroughly acclimatized in Spain, where it is double-brooded, has been extensively reared in the United States of North America, during the year 1880, from live cocoons I sent to various parts. A correspondent in Illinois writes that it was double-brooded there, and that he found some of the worms (which had left oak trees, the foliage of which had become dry and tough in consequence of the hot, dry summer), feeding on hawthorn bushes growing close to the oak trees. Other *Pernyi* larvæ were found on apple trees in a garden, where they reached an enormous size. In France some were reared successfully on plum. According to a statement of my Spanish correspondent, *Pernyi* is essentially an oak feeder, which will degenerate after a time, if fed on other trees than oak.

Telea Polyphemus (North America).—This silkworm, which produces a closed cocoon, a little smaller than that of *Pernyi*, is the best of the silk producers of the United States of America. The silk is white, very fine, and seems to be of a very superior quality. It can easily be bred like *Pernyi* in the open air, in England, unless the weather should be exceptionally bad. *Polyphemus* is now acclimatized in Spain, where I introduced it in 1879. In 1880, some 1,500 wild cocoons were collected from oak, birch, and other trees. It is very polyphagous. My Spanish correspondent considers *Polyphemus* as a valuable acquisition to sericiculture in Spain, but he says it has a tendency to become double-brooded there, two male moths having emerged in November. The larvæ thrived well on birch (*Betula alba*). My correspondent in Alabama, from whom I have just received some *Polyphemus* cocoons, which are very small, and covered with leaves of a species of ever-green oak, says it is double-brooded in Alabama, as it must be in all the Southern States of America; in the Northern States it is single-brooded.

Samia Gloveri.—In 1880, I received a large number of cocoons of this North American bombyx. They were collected, my correspondent wrote to me, some 40 miles south of Salt Lake City, Utah, in a locality which had never been previously explored. As far as I have been informed, this fine species, up to the present, has only been found in Utah and Arizona. The cocoons were collected in plantations of a species of willow with small narrow leaves. The cocoon, somewhat similar but smaller than that of *Samia cecropia*, is generally of a silvery gray outside; the rough envelope adheres to the cocoon inside, which is of a very dark brown. The *Gloveri* moths emerged from the middle of April to the middle of July, but no pairings could be obtained.

Samia Ceanothi.—This species, a little smaller than *Gloveri*, is a native of California. The moths do not vary in shades of colors like *Cecropia* and *Gloveri;* the ground color of the wings is of a uniform reddish brown; the bands and markings are pure white. *Gloveri* partakes of *Ceanothi* and *Cecropia*, as if it were a cross between these two species.

The cocoon of *Ceanothi* is very different from that of *Gloveri* or *Cecropia;* it has the open end very pointed, and is pear-shaped; its color is iron-gray. The inside cocoon is brown, and small, compared to the outside envelope.

The moths of *Ceanothi* (of which I had reserved 40 cocoons) emerged from the 3d of April to the 18th of July; a perfect specimen had emerged in March. Two pairings only were obtained: The larvæ bred on plum and willow did not thrive, and died in first and second stage, a few going into third stage. From a letter recently received from one of my German correspondents, Herr H. Wolff, of Breslau, I hear that three cocoons were obtained by this entomologist with only six eggs at his disposal, a very great success, considering that failure has attended the efforts of several others in the rearing of this species.

The first pairing of the *Ceanothi* moths took place on the 27th of June, the second on the 10th of July. The ova of the first brood hatched 18 days, and those of the second 15 days after having been deposited.

The larvæ, somewhat similar to those of *Cecropia* in the first and second stage, but of a lighter color, showed a marked difference in the third stage, and were thus—Back of body, sky-blue; sides, greenish yellow; tubercles, golden yellow all along the back, and on the sides, blue; head green.

Hybrids.—Although *Samia gloveri* moths refused to pair among themselves, I had several crossings between *Gloveri*, *Ceanothi*, and *Cecropia*. The ova obtained from a long pairing between a *Ceanothi* female and a *Gloveri* male were the only ones which were fertile. Unfortunately the larvæ, reared on willow and plum, all died. some reaching, like *Ceanothi*, the third stage. The pairing of *Ceanothi* and *Gloveri* was from the evening of the 20th to the evening of the 21st of May. The larvæ hatched from the 15th to the 21st of June, the majority having hatched on the 16th and 17th of June. All the ova hatched, excepting a few—over 200 in all. First stage—Larger larvæ, black; smaller ones, buff, the colors becoming of a more uniform hue as the larvæ increased in size. They were very much like *Cecropia* larvæ. Second stage—Larvæ, yellow, with black tubercles; head, black. Third stage—Back, bluish; sides, yellow; tubercles on back, orange-red; tubercles on sides, blue; head, yellow.

Eight larvæ, the produce of a pairing of female *Saturnia pyri* with unknown *Samia* (the pairing was not seen); lived seven days on plum; they were bright yellow, with a dark ring round each segment.

The other crossings resulting from the keeping of various species together in large cages, when male and female moths of the same species could not be obtained simultaneously, are the following: In a hot-house, at a gardener's, on the 22d of May, *Telea polyphemus* (female) with *Attacus mylitta* (male), of the Bombay race; *T. polyphemus* (female) with *Attacus pernyi* (male); *Samia gloveri* (female) with *Pernyi* (male). In my house, at ordinary temperature, on the 12th and 13th June, *Samia ceanothi* (female) with *S. cecropia* (male); on 15th June, *S. gloveri* (female) with *S. cecropia* (male); on the 18th and 19th of June, *S. cecropia* (female) with *S. ceanothi* (male). In all the above cases, the ova were unfertile.

The difficulties I have experienced to obtain living cocoons from India and other distant countries, induced me last October to write an article on the collecting and rearing of larvæ, and on the best plan to be adopted for the sending of cocoons and pupæ, so that they should arrive in England in good condition. This article was sent to India, China, and South Africa. It appeared in the *North-China Herald*, of November 25, 1880, and in the *Madras Athenæum* and *Daily News*, of Saturday, December 4, 1880. It was sent also to correspondents for insertion in the *Times of India* (Bombay), the *Calcutta Englishman's Overland Mail*, and the *Cape Argus*.*

Persons residing abroad, who may be willing to collect and rear larvæ of *Lepidoptera*, will find this a most interesting and instructive study. It is within the reach of all, and is at the same time profitable, as the pupæ and cocoons obtained would be purchased from them by other collectors. Larvæ can be found in almost unlimited numbers by using a sweeping-net over low plants, or in beating bushes, shrubs, and trees, placing an umbrella under the branches to receive them. Larvæ which hide themselves in the daytime can only be found in large numbers by looking for them at night with a lantern.

The rearing of the caterpillars, after a little experience, will be found extremely easy. Some will require to be placed in cages, when active and apt to run away; others, like the silk producing Bombyces, may be reared uncovered on branches plunged into water, care being taken to use long branches (never small twigs) when the larvæ are large. When very small branches are used, the foliage becomes too watery, and it may cause the death of the larvæ. Cut leaves have to be renewed too often, and therefore should be avoided, to feed the larvæ whenever cut branches plunged in water can be used. Branches should also be cut in the evening or early in the morning, and not in the day-time when the sun is hot, as, in the latter case, the foliage would soon be faded. When trees in pots can be used to feed the larvæ, the rearing is, of course, more simple, and there is a saving of time. Another plan, which is the best to rear larvæ forming cocoons in the leaves or on the branches, is to place them on the living tree in the open air, taking care to protect them from birds.

To give fresh food to larvæ reared on cut branches kept in water, when the foliage has been eaten, or is too old and dry, is very easy. The old branches are merely placed in contact with fresh branches, or the old branches cut in pieces (not to be too heavy) are placed on the new ones. The larvæ, which should not be handled, will leave the old branches to go to the fresh ones. In a short time the old branches, bare of larvæ, may be removed.

When branches are plunged in a bottle, or any other vessel containing water, the foliage at the base of the branch should be cut off, as leaves in the water would decompose it, render the rest of the foliage unwholesome, and even poison the larvæ. The cut branches in water should be placed in the shade, where they will keep fresh for several days, especially if the foliage is sound and healthy, a condition of great importance. The water should be renewed, and the foliage freed of green flies and other small insects.

To rear *Lepidoptera* from the egg the moths should be placed in cages for pairing and depositing their eggs. With moths of *Sphingidæ* and some other species, it is useful to put in the cage a bunch of aromatic flowers, with branches of the plant the larvæ feed upon. Moisture should always be maintained in the cages.

A few days, or immediately after the eggs have been obtained, they should be placed under a glass with a small branch or leaves of the proper plants, so that the larvæ should find their food as soon as they are hatched.

When the larvæ are small, I rear them under bell-glasses, having a few holes on the dome. These glasses, which are of various sizes, according to the number of larvæ, rest on saucers full of sand covered with a piece of paper. Small branches of the proper food plants are stuck through the paper and plunged into the sand, where they keep fresh for several days without requiring any water.

The larvæ, under a bell-glass, can be watched and kept perfectly clean, for, after having removed the glass, it is sufficient to blow on the paper to remove all the dejections. Some larvæ may thus be reared till they turn into pupa state, under glasses one foot high and one foot in diameter, or larger, according to the size of the larvæ. With larvæ of the large silk-producing and other Bombyces, after the first or second moult, when they have ceased to wander, it is best to rear these without the glass covering; branches plunged in water are then used, as mentioned before. The larvæ should be reared in the open air, but sufficiently protected, or in a well ventilated room. Larvæ which go into the ground to turn into the pupa state should be reared in cages containing a few inches of light soil or soft sand, and this plan must always be adopted when the habit of the larvæ is not known.

Now, with respect to the sending of living cocoons and pupæ from abroad, on the cases there should be written in large letters, "living pupæ," or "living cocoons of silkworms," with request to keep the cases in the coolest place, or in the ice-house of the vessel. The cocoons should be well packed in straw, hay, moss, or anything that will deaden the shocks to which the cases may be subjected. Pupæ of lepidoptera must be placed in bran, sawdust, or fine moss. Cocoons and pupæ should be sent as soon as possible after their formation, from the beginning of October to about the beginning of April, according to distance, so that they should not be subjected to the heat the whole of the time during their voyage to England. Small quantities of cocoons and pupæ should be sent by sample post, in registered boxes, not exceeding the legal weight; the boxes must be strong, and it is best to tie a label to each box, and affix the stamps to the label. Persons living too far inland to send living pupæ may send dead specimens of the perfect insects (butterflies and moths). These should be in good condition, and placed with folded wings in paper envelopes. To protect these specimens from the attacks of mites, "Dermestes" beetles, and other parasites. it is important to put some poison in the boxes containing the specimens.

With respect to the sending of live cocoons and pupæ, and even ova of lepidoptera, I may say, that with a little care, and especially if they were given in charge of the captain, or some other person on board ship, they could be sent to Europe from distant countries, and arrive alive and in good condition.

In proof of this, I may mention the fact, that Mr. Youl, acting as agent of the Tasmanian Government, shipped, in 1864, packed in a box, which was placed in the ice-house of the steamer Norfolk, a large quantity of salmon and trout ova, the result being the successful introduction of salmon and trout into the rivers of Tasmania and Australia.

In the same way, silkworm ova, live cocoons, and pupæ could safely be sent to Europe, from very distant countries, and this would be of the greatest interest and value to entomologists, for the study of lepidoptera in their various states.

To conclude, I shall reproduce the letter of one of my correspondents, Mr. J. P. Cock, whose death I accidentally learnt, on the 18th November last, in a house at Thames

* From a letter just received from Major G. Cousmaker, I hear that the article appeared in the *Times of India*, and also in the *Indian Agriculturist*.

Ditton, from Mr. P. Clarke, a gentleman who is a tea-planter in Assam. This sad news was recorded in an Indian paper, the *Assam Gazette*, of October 25, 1880, which, at my request, was forwarded to me a few days after.

I now give my correspondent's letter to me, dated 14th February, 1880, and received on the 12th of March, 1880:

KASSIA HILLS, ASSAM.

"DEAR SIR: You must have thought it very remiss on my part, allowing your letter to remain so long unanswered, but a sudden and unforeseen calamity, in the death of my only brother, Major Cock, Deputy-Assistant Adjutant-General, Eastern Counties Districts, who fell mortally wounded while leading on his men in the final assault on Khonoma, in the Naga Hills, has entirely prevented me paying any attention to entomological pursuits for the last three months.

"My poor brother, having died possessed of a good deal of landed property in no less than three of our Indian hill stations, I have been traveling incessantly winding-up his affairs; in fact, I may with perfect truth say, that for the last two months and a half, I have been living in railway carriages and on board river steamers.

"The old adage, that misfortunes rarely come singly, I have found in my case to be true, for on my return to this station last Thursday, I found that my bungalow had been burnt to the ground through the gross carelessness of a drunken syce. Nothing was saved. A magnificent and most expensive library of entomological works, 47 large cabinets of specimens (my own private collections), my gleanings for over 26 years in Sumatra, Java, New Guinea, Borneo, Calebes, the Philippine Islands, and Japan, over 4,000 specimens ready to forward to England—all was lost just through the carelessness of a drunken wretch capsizing a lamp in my stables.

"I keep up a staff of eight Rhapias, whom I have thoroughly trained for the work of collecting in the malarious jungles, where it is almost certain death for a European to sleep one night. I likewise have a large circle of friends and acquaintances among the officers and tea planters in the districts, all of whom I have persuaded to collect for me, and who send me monthly what they have been able to accumulate, and as I always take the field myself in March, and do not generally leave the forests before autumn is far advanced, many thousand insects pass through my hands annually.

"As before stated, all my large stock of preserved insects had been lost in the fire; however, I hope in the course of a month, or six weeks at the latest, to be able to dispatch you a first consignment. I will pay particular attention to your wishes about the cocoons of our various silk moths, and have already received letters from two intimate friends, who, perhaps, are two of the most eminent entomologists in India—Capt. Marshall and Col. Jones—both officers in the Royal Engineers. They inform me that they have written to some of their correspondents in other parts of the Himalayas to procure cocoons of such of the silk moths as are not procurable here. I can, however, promise to send you any number of cocoons of the following species: *Attacus assamensis, Attacus atlas, Actias selene,* and *Actias mænas.* Will you kindly write to me by first mail after the receipt of this, what cocoons do you consider most valuable, and the particulars that may be useful to me in forwarding them?

"I shall probably be away in the wilds of the Naga hill forests, but your letter will be forwarded on without delay. I should very much like to see some of your reports, it would give me very much pleasure to read them; and in return, will forward you a copy of my book on the genus *Deilephila*, which ought to be completed and published next month. It includes all the known Asiatic species of *Cherocampa, Sphinx, Macrosila, Smerinthus,* and the illustrations, over 400 in number, have taken me nearly three years to complete, as I have drawn each moth in water-colors as soon after capture as possible, with representations of the egg, caterpillar, and tree on which they live.

"As the season is not sufficiently advanced to take the field, hard frosts and bitterly cold winds prevailing at this lofty elevation, where anything in the shape of vegetation is parched and dried up, I am, at present, hard at work on the illustrations for a work of Captain Marshall's, on 'Our Indian Lepidoptera.' When completed it will be the most perfect work on Asiatic lepidoptera ever given to the world, over 2,000 specimens illustrated.

"About a dozen of us are starting a new monthly entomological magazine; how it will answer I cannot tell; fortunately, all men concerned in it are tolerably well off, so, if it fails, we shall none of us be ruined.

"Hoping to hear from you in reply to this, giving me all the information in your power about the cocoons, I remain, etc."

After the receipt of this letter, to which I replied three times, I never received any communication from my correspondent, and, as above stated, it was by mere accident that I heard of his death.

ALFRED WAILLY.

110 Clapham road, London, S. W.

THE MODE OF FLIGHT OF THE ALBATROSS.

THERE seems to be a prevailing idea that the albatross in his flight is in some way "assisted by the wind." I think this is a mistake; the manner is well known. The method, I believe, admits of a very simple explanation. His secret consists in his power of acquiring great momentum, together with the large superficial area of his extended wings; with scarcely a motion of his wings he will fly straight against a strong wind with a velocity greater than that of any racehorse; this is inconsistent with the idea of his being "assisted by the wind."

In attempting to rise from the water (I believe he is unable to rise from the land or from a ship's deck) he flaps his wings violently to get his body out of the water; at the same time, paddling rapidly with his webbed feet, he acquires a moderate degree of momentum, sufficient, with outstretched wings, to carry him forward and upward upon an easy incline. The case is similar to that of a boy taking a run with his kite string in his hand to give his kite a start. During this first rise he will generally give a few heavy, lazy flaps, and then stretch his wings steadily to their full extent; now as he gradually rises he must, of course, as gradually lose his acquired momentum till it suits him to acquire more, when he may be twenty, thirty, or fifty feet above the surface, but a much greater distance from the place where he left the water, measured on the surface; by slightly altering his position, by a movement of his tail, he takes a shoot downward at any angle that suits his convenience, still without his wings outstretched. This is precisely the case of a boy shooting down a coast on his sled; the propelling force is the same. The bird directs his course mainly with his tail, the action of which upon the air is identical with the action of a ship's rudder upon the water. By this downward motion, his velocity rapidly increasing, he acquires a degree of momentum sufficient to carry him up again to a height equal to or greater than that from which he started. In this up and down long wave-like motion, with all its variations on either side, consists the whole of his flight day after day for hundreds of miles; at long irregular intervals he may give a few lazy flaps with his immense wings. Other birds use the mode of flight of the albatross, but to a smaller extent, for the reason, in the case of smaller birds, that, the ratio of feathers to bulk being greater, their specific gravity is less, consequently they are unable to acquire the degree of momentum necessary to carry them upward; but on the other hand they have the power of sustained effort in moving their wings rapidly, which the albatross has not. Gravitation then, which prevents him from rising directly on the wing, is the motive power of the albatross when aloft. He must always take a run or paddle over the surface of the water in order to get a start, and on the land or the deck he is a prisoner, because he has no water in which to paddle himself along with his webbed feet, and he is unable to run. Instead of being assisted by the wind, his speed is lessened by just so much as the wind's velocity, when it happens that the direction of the wind and his intended course are opposed to each other, but with the wind his speed is just so much greater than it would be in a calm.

I do not advance this explanation as an imaginative theory. I claim more for it. I have had many opportunities of studying the movements of the albatross for consecutive days, and I feel confident that the above will be found to answer all required conditions.—*Howard Sargent, in Nature.*

ARCHÆOLOGICAL EXPLORATIONS NEAR MADISONVILLE, OHIO.

THE valley of the Little Miami River, in southwestern Ohio, has been long noted for the number and extent of its prehistoric earthworks, which, distributed on both sides of the river, from its confluence with the Ohio to the well known Fort Ancient and beyond, form an almost continuous chain of mounds, forts, circles, and embankments, extending for more than fifty miles, and constituting an important division of the great earthwork system of the Mississippi Valley.

In October, 1878, Dr. Charles L. Metz contributed to the "Journal of the Cincinnati Society of Natural History" a

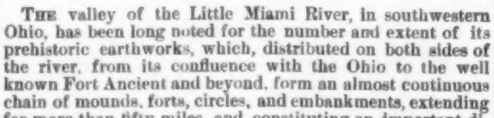


Fig. 1.—Section of Mound No. 5, Group A.

paper on the aboriginal remains of this vicinity, accompanied by a chart on which the mounds and earthworks were designated by symbols in accordance with the international code of MM. Mortillet and Chantre. The examination and exploration of these remains, which was begun by Dr. Metz and a few other gentlemen, was prosecuted under the auspices of the Literary and Scientific Society of Madisonville, during the years 1878, 1879, and 1880, and the results are perhaps among the most interesting of any that have been conducted in the Mississippi Valley. The following

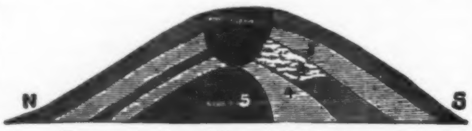


Fig. 2.—Section of Mound No. 6, Group A.

brief outline of the work and the discoveries that were made during the progress of it are condensed from the full report communicated to the Cincinnati Society of Natural History, and published in its "Journal" (vol. iii., numbers 1, 2, and 3).

In November, 1878, the earthwork known as Spice Bush Mound, was opened under the direction of Dr. Metz. The accompanying sketch (Fig. 1) shows the stratification of this mound, as seen in Section. No. 1 is a stratum of black leaf mould and gravelly clay, about one and a half to two

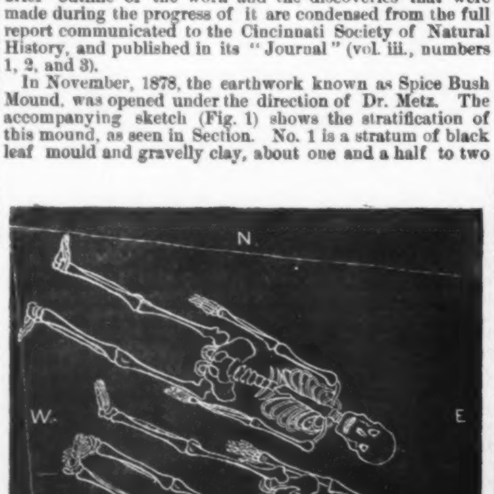


Fig. 3.—Group of Three Skeletons.

feet thick. No. 2 is an irregular layer of clay and sand. No. 3 is a bed of calcined limestone, eight inches thick, with ashes and sand. No. 4 is a layer of pure sand, and No. 5, the center of the original, though not exactly that of the present mound, is a peculiar, compact, grayish earth, looking very much like dry mortar. During the progress of the work, five much decayed, irregularly-disposed skeletons were found, which were remarkable for their small size—averaging but 5 feet 2 inches in length. All these were undoubtedly intrusive burials, and appear to have been thrown upon the original mound irregularly. A number of fragments of burned limestone, broken bowlders, a few flint chips, and two small fragments of pottery were found in the mound.

During the same month, another mound, situated on the

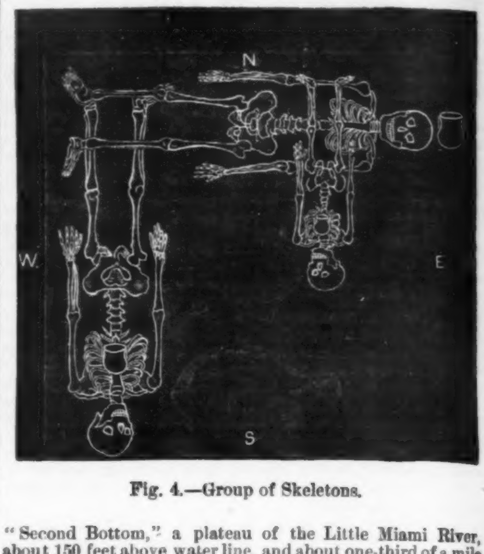


Fig. 4.—Group of Skeletons.

"Second Bottom," a plateau of the Little Miami River, about 150 feet above water line, and about one-third of a mile from the river, was explored. The section of this is shown in Fig. 2. In the center there is found a small circumscribed deposit of ashes, mixed with fragments of charcoal and charred bones, and with these were mingled fragments of a human skull, perfectly sound, so far as the action of fire was concerned, but soft and friable through decay. The excavated material was thrown back, and the mound restored,

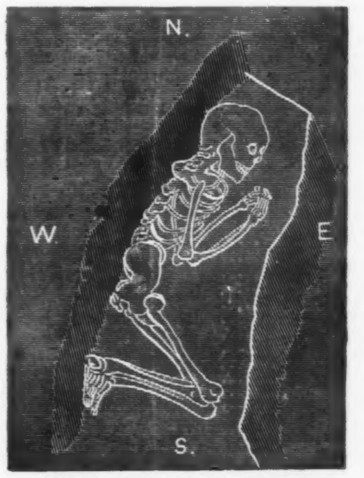


Fig. 5.—Skeleton of Old Person.

as nearly as possible, to its original condition. In the month of March, 1879, during the progress of work on mound No. 5, group A, a laborer, while prospecting by digging holes in the surrounding forest, came upon a human skeleton at a depth of about two feet. This was the initiatory step toward a most important archæological discovery, as further investigation has revealed the fact that the entire plateau is the site of an ancient cemetery, from which have since been exhumed upward of four hundred skeletons of a prehistoric people, accompanied by numerous evidences of their handi-

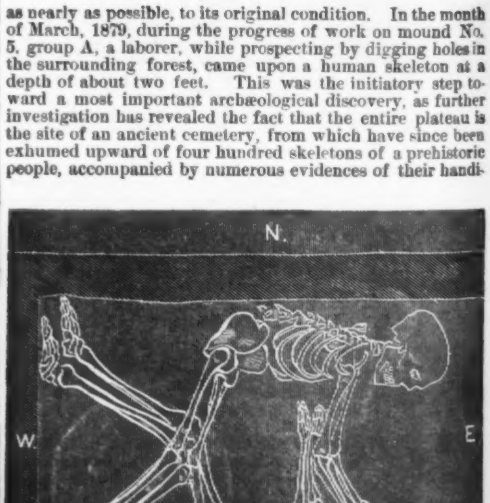


Fig. 6.—Two Skeletons.

work, in the shape of flint and stone implements, pipes, pottery, charred matting, and corn, tools, and implements of bone, shell, and copper, some of which are believed to be unique, all indicating an industrious people, who lived in large communities, and obtained their support by cultivating the soil, as well as by fishing and hunting.

The original forest still covers the site of this cemetery, and measurements of some of the trees are as follows: a

walnut, 15½ feet in circumference; an oak, 12 feet; a maple, 9¼ feet; an elm, 12 feet. The locality has long been known to local archæologists as the "Pottery Field," so called on account of the numerous fragments of earthenware strewn

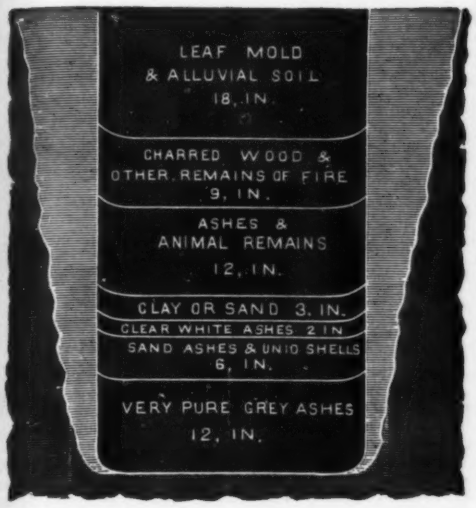


Fig. 7 —Diagram of Ash Pit, No. 53.

over the surface; and it was until recently supposed to be a place where the manufacture of pottery had been carried on by the ancient inhabitants of the valley. The exploration of the cemetery, since its true character was discovered, has been, as far as the ground gone over is concerned, exceedingly thorough. Of the skeletons exhumed but a small proportion are in a good or even tolerable state of preservation; and the preservation of even these few must probably be ascribed to the favorable character of the soil—a compact

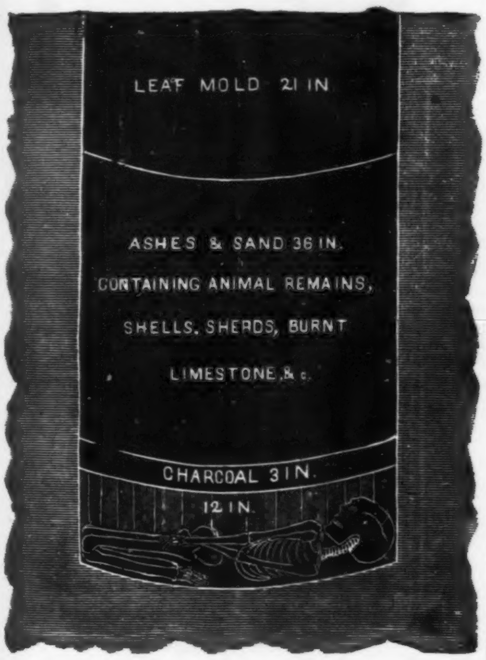


Fig. 8.—Ash Pit with Human Remains.

gravelly drift—since the various surroundings, the position of some skeletons under large trees, etc., all indicate for these interments a remote antiquity.

The mode of burial seems to have been far from uniform. A large majority of the skeletons are found at a depth of two to three feet, in a horizontal position, face upward; but exceptions to this rule are numerous, many interments being made in a sitting posture, and some in groups of from three

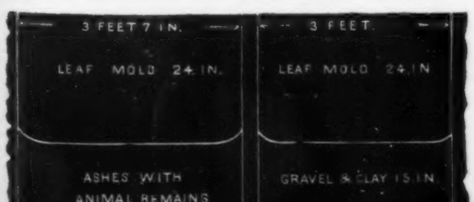


Fig. 9.—Diagram of Double Corn Pit.

to six individuals regularly (Fig. 3) or irregularly disposed. Fig. 5 shows the skeleton of a very old person, which was uncovered June 16th, 1879. Its position was partly extended, lying on its side, face east, with hands raised and knees projected. The two skeletons shown in Fig. 6 were found directly over an ash pit; they were in semi extended positions, heads directed east and west, and lower limbs crossed. There has been no attempt in any instance at the construc-

Fig. 10.—Earthen Burial Vessel (Dr. Metz). One-third size.

tion of a stone coffin, but in one case the skeleton was covered with a layer of small flat limestone from the adjacent stream. The heads of those in the horizontal position are generally directed to the east or southeast; but this rule is

Fig. 11.—Small Vessel (C. F. Low). One-half size.

not constant, several being found at right angles to these (Fig. 4). It is worthy of note, however, that with scarcely an exception, those skeletons which are accompanied by the finer vases, pipes, or other choice relics, have their heads

Fig. 12.—Ornamental Vessel (G. W. Lasher). One-third size

directed east or southeast. Among the graves opened were several of children, who were usually buried in close proximity to adults, and with them are found various ornaments or toys of perforated bone, shell, etc., as well as small earthen

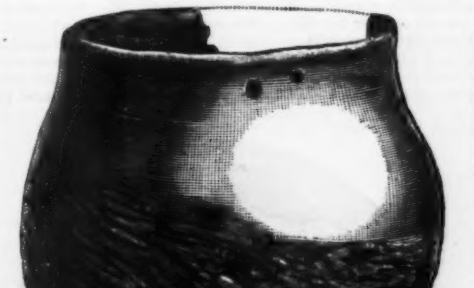


Fig. 13.—Earthen Vessel (Joseph Cox, Jr.). One-half size.

vessels. Among the human remains from this cemetery are many possessing features of surgical and anatomical interest, as, for example, an adult male cranium in which complete anchylosis of the atlas to condyles has occurred, the posterior arch remaining free. Other crania show evidences of severe injury with subsequent repair, and among the long bones are several showing characteristic lesions strongly indicative of rachitis and of syphilis, a fact of considerable

Fig. 14.—Small Double Vessel (G. W. Lasher.) One-half size.

interest in its relation to the geographical distribution of the latter disease, and also as bearing on the theory of its introduction into Southern Europe from America in the fifteenth century.

An interesting feature of these excavations has been the discovery of what may be designated as "ash pits;" being

Fig. 15.—Large Vessel (C. F. Low). One-third size.

circumscribed deposits of ashes, shells, sand, etc., from two to three feet in thickness, placed at varying distances below the surface. A perpendicular section made of one of these pits (Fig. 7) answers to the following description, which will serve to convey a fair idea of them all. Diameter of pit, 3 feet; the first 18 inches, of leaf mould and alluvial soil;

Fig. 16.—Earthen Vase (Joseph Cox, Jr.). One-fourth size.

then 9 inches of charred wood, burnt earth, and charcoal; next, 12 inches of ashes and animal remains; then 3 inches of clay or sand; next, 2 inches of white ashes; 6 inches of sand and *Unio* shells; and, finally, 12 inches of pure ashes. Total depth 5 feet 2 inches. These pits are quite uniform in size. Intermingled with the ashes are pipes, implements

FIG. 17.

of bone, shell, and stone, a mastodon's tooth, bones of various wild animals, including birds and fishes, and in some of them large sherds of pottery ware, indicating vessels of from ten to twelve gallons capacity, or even larger. In one

of the pits, opened January 29th, 1880, there was found at the bottom an entire human skeleton (Fig. 8); but this is an exception to the rule, since in no other case but one were human remains discovered, and that was a single dorsal

Fig. 18.—Earthen Vessel. One-third size.

vertebra only. The discovery of this skeleton furnishes some clew to the purposes of the pits, and favors the view that they were probably places for temporary burial, from which the remains were afterwards removed for interment

Fig. 19.—Vessel with Salamander Ornamentation. One-third size.

in some of the numerous sepulchral tumuli usually called "battle mounds," or "sacrificial mounds." That these pits are very ancient is evident from the fact that subsequent

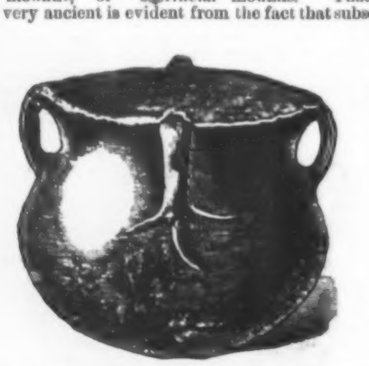


Fig. 20.—Vessel with Salamander Handles. One-third size.

interments, in both sitting and horizontal positions, have been made directly over these excavations since the removal of the human remains, and forest trees of several hundred years' growth are now growing over these comparatively

Fig. 21.—(W. C. Rogers' Collection.) Inscribed Stone from Ancient Cemetery, Madisonville, Ohio.

later interments. One of the most interesting discoveries, aside from the skeleton, in connection with these ash pits, was made August 26th, 1879. In excavating a pit, a large deposit of several bushels of carbonized maize was found. A correct diagram of the pit (Fig. 9) is here given, along with a brief description of its contents. First, 2 feet of rich black earth and leaf mould. Second, 16 inches of gravelly clay, in which were numerous animal remains, several im-

Fig. 22.—Stone Pipe (R. O. Collis)

plements of flint, stone, and bone, an unfinished pipe, and some charred bones. Third, 10 inches of ashes, intermingled with the bones of a great number of animals. Fourth, about 5 inches of coarse matting and twigs, cornstalks and bark, all completely carbonized. Fifth, a layer of shelled corn, probably 3 or 4 bushels, and below this a quantity of ear corn, all of which was completely carbonized. The bottom of the pit was covered with a layer of fire cracked bowlders, some ashes, and a few animal bones. The adjoining pit was separated from the corn pit at the bottom by about six inches of clay, and did not differ from the usual pits, except that no implements were found

Fig. 23.—Stone Pipe (Joseph Cox, Jr.).

in it. From the uncharred condition of the articles usually found in the ash pits it is evident that the ashes have been placed in the pits *as ashes*, after having been burned elsewhere, as in no case do the walls of the pit show any traces of the action of fire.

The pottery ware which accompanies the skeletons is usually found situated near the head, and present many features of special interest. It is made of clay, finely tempered with powdered *Unio* shells, and much care has evidently been bestowed on its manufacture, some pieces being scarcely thicker than an ordinary teacup. Many specimens are in a perfect condition, or nearly so, and they usually contain a

Fig. 24.—Stone Pipe (C. F. Low).

single *Unio* shell when found, the shell being evidently intended for use as a spoon. The vessels range in capacity from a third of a pint, or even less, up to a gallon or more—the smaller ones being found in the graves of children. They are symmetrical in shape and varied in design, some being artistically ornamented with scroll work, some with handles representing lizards, human heads, etc., and they are almost universally provided with four handles. Fig. 10 shows an earthen vessel; found in a fine state of preservation, near a skull, in March, 1879. Fig. 11 represents a vessel found in an ash pit April, 1879. Fragments of two other vessels were found in the same excavation. On May 7th, of the same year, along with a skeleton six feet in length, was found the

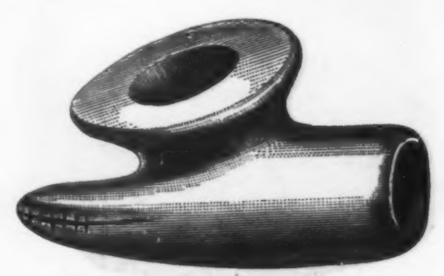


Fig. 25.—Catlinite Pipe (E. A. Conkling).

finely shaped ornamented vessel shown in Fig. 12. In lieu of the usual handles there were two perforations on each side and two small projections on each quarter.

The curious, gourd shaped earthen vessel shown in Fig. 13, was found along with a skeleton in July.

Fig. 14 represents a small, two-story vessel, which was exhumed from a grave containing seven skeletons, two of which were those of children.

Fig. 15 represents a fine, perfect vessel, of about one gallon capacity, found at the feet of one of a group of skeletons, in the month of July.

Fig. 26.—Stone Pipe (G. W. Lasher).

Fig. 16 represents a vessel which was taken from the right side of the head of a male skeleton, October, 1879. It is provided with a base or pedestal, and is the only one of this peculiar form which has as yet been discovered.

In Fig. 17 is shown a peculiar narrow-necked vessel which was found under a skull in one of the ashpits, November 27, 1879. Originally it had four handles, as shown by the dotted lines.

On February 10, 1880, in excavating in what was supposed to be a hearth or irregular ashpit, it became evident to the explorers that the place was a kitchen-midden. The leaf mould was of about the same depth as in other parts of

Fig. 27.—Catlinite Pipe (R. O. Collis).

the cemetery, and several skeletons were found within the space. Along with a group of five of these was discovered the broken vessel, ornamented with a human face at the left side, seen in Fig. 18.

Fig. 19 represents a vessel which was found crushed between two skulls, but which was afterwards carefully restored from the fragments. The salamander-like ornamentation of this vessel is entirely new and peculiar to this cemetery. Several fragments and handles of other vessels have been found representing four or five species of the *Salamandridæ* or other *Urodelæ*.

With the remains of one of three skeletons exhumed July

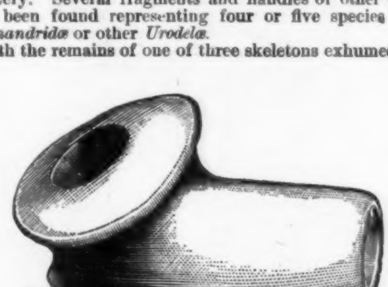


Fig. 28.—Stone Pipe (A. A. Hawes).

4, were found two bone beads, a large number of copper beads, and the small, perfect vessel, with salamander ornamentation, shown in Fig. 20. This vessel was found near the lower extremities of the skeleton, which was that of an adult female.

There is a good reason to believe that each interment was originally accompanied by a vessel, although at present there is a great disparity between the number of these and of the skeletons found. This is perhaps to be accounted for by the fragments thickly strewn over the surface and inter-

Fig. 29.—Pipe (P. G. Thomson).

mingled with the surrounding soil—these having doubtless at one time constituted portions of the missing burial urns.

Among the other articles of utility or ornament found in the graves are pipes of various patterns, several of them being made from the Minnesota catlinite or red pipestone; also stone disks, axes, and chisels, flint knives and spear-

heads, and many ornaments and implements of bone, such as beads, awls, needles, perforated teeth, etc., together with others of unknown uses. Among the collections are three stones bearing engravings or inscriptions. One of these, now in the collection of Mr. F. W. Langdon, is an irregular

Fig. 30.—Limestone Pipe.

piece of sandstone, measuring about 3×2×1 inches, on the flat surface of which are cut two parallel figures made of straight lines and apparently intended to represent arrows. The second stone, in the collection of E. A. Conkling, is a flattened dark-green bowlder measuring about 3½×2½ inches, one side of which is covered with a network of lines from ⅛ to ¼ of an inch apart and crossing each other at

Fig. 31.—Sandstone Pipe.

nearly right angles, thus forming quadrangular divisions of various sizes. The third (Fig. 21) was found in an ashpit in September, 1879. It is an irregular piece of fossiliferous limestone of a reddish-brown color, as though it had been stained by being deposited in a ferruginous soil, the fracture on the edge showing the natural color of the limestone. The markings are incised lines and the pointer is the most

Fig. 32.—Limestone Pipe.

prominent figure; the other lines are plainly visible, although the surface is much weathered and worn. The stone and markings, perhaps, have reference to the pit of carbonized maize, near which it was found, and it is to be regretted that the exact position in which it originally lay was not noted.

Fig. 33.—Sandstone Pipe.

The following are some of the pipes found:

Fig. 22 represents a fine limstone pipe, found in March, 1879, and now in the collection of Mr. R. O. Collis.

Fig. 23 is a stone pipe in the shape of an animal's head, found in an excavation along with a small vessel of a pint capacity, and two rough stone axes or fleshers.

Fig. 25 represents a finely-finished pipe, of curious form, made of dark red catlinite. It was found with five skeletons, all of which were in a horizontal position.

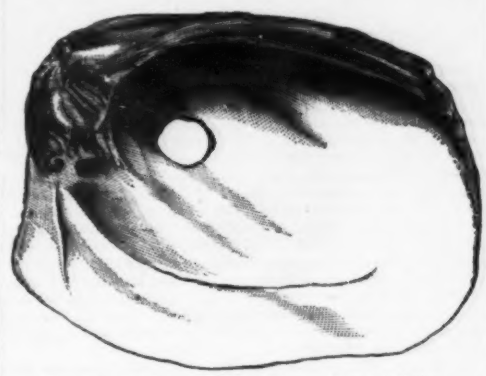


Fig. 34.—Perforated Unio Valve. One-third size.

Fig. 26 shows an ornamented stone pipe, found with an earthen vessel in an excavation made in April, 1879. This is now in the collection of Mr. G. W. Lasher.

Fig. 27 is a finely polished catlinite pipe, which was found near the vessel numbered 12, above.

Fig. 28 represents a pipe made of limestone, which was discovered during one of the May excavations, lying near the cranium of a skeleton.

With a skeleton exhumed in October, 1879, was found, at

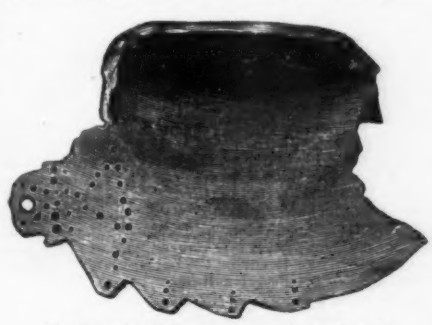


Fig. 35.—Shell Ornament (D. S. Hosbrook).

the right of the head, a broken vessel, and on the left side a pipe, Fig. 29, made of limestone, and carved to represent the head of some animal. A copper ornament, Fig. 40, was also found at the right side of the neck.

Fig. 30 represents a pipe of peculiar form, made of limestone, which was taken from an ashpit, April, 1880.

Fig. 31 represents a small sandstone pipe, which was picked up on the surface, at about fifty feet from where an excavation was being made in May. This relic is ornamented with rude carvings, representing a bird with out-

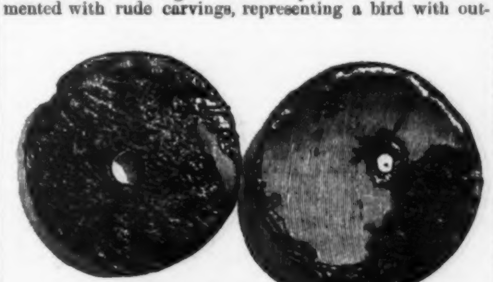


Fig. 36.—Shell Ornaments (Mr. Ferris).

stretched wings, and had been rooted up by the hogs which had been turned loose in the woods.

Fig. 32 represents another pipe, which was also found on the surface. The material is limestone.

Fig. 33 shows a sandstone pipe, which was found in June in an ashpit, along with two rolls of copper, five bone beads, one ungrooved ax, and a stone dresser.

Numerous perforated implements and ornaments made from the shell of *Unio*, were found in the ashpits, and of which Fig. 34 is an illustration of the largest one discovered.

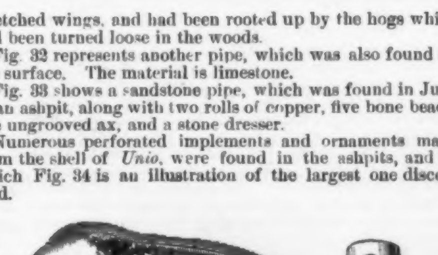


Fig. 37.—Shell Ornament and Bead.

Fig. 35 shows a shell ornament, which was found with a vessel, near a skeleton in one of the pits.

Fig. 36 represents ornaments of shell found near the skeleton of a female, December, 1879. These consist of two perforated shell disks about the size of a silver dollar, and a pendent made of the hinge of a large shell, with a deep groove at the smaller end. These were found near the neck of the skeleton.

Fig. 37 shows a shell ornament and bead, which were

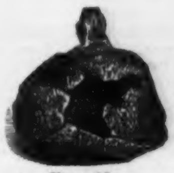


FIG. 38.

found in May, 1880, near the remains of an adult female and a child.

Fig. 38 represents a very interesting object, perhaps a rattle, which was found with the skeleton of a child in September, 1879. It is made of a single piece of copper of irregular shape, the edges of which have been brought together so as to form a bell, or rather what looks like a sleigh bell, leaving an irregular opening on one side. A small hole was punched through the top and a strip of copper doubled up and the ends pushed through the opening from the inside so as to form a handle. Inside this bell is a fragment of copper, about the size of a large pea, and when the object is shaken it produces a rattling or tinkling sound.

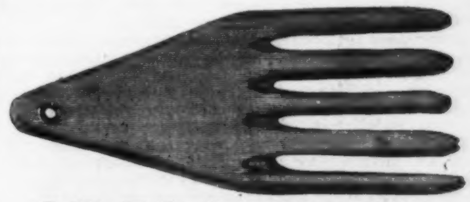


Fig. 39.—Elk Horn Ornament (E. A. Conkling).

It is without question one of the most unique specimens of aboriginal workmanship ever recovered.

From an ashpit opened in October, 1879, was taken the singular ornament represented in Fig. 39. It is made of elkhorn, and may possibly have been utilized as a comb.

The copper ornament shown in Fig. 40 has already been spoken of above.

As regards the particular race to which the people belonged whose remains are found in this extensive cemetery—whether they were identical with or related to the celebrated "stone-grave people" of Tennessee, as some of their potteryware and the shape and dimensions of their

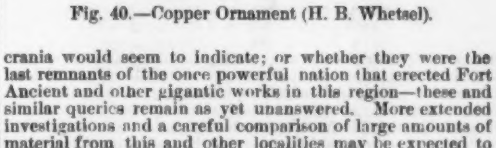


Fig. 40.—Copper Ornament (H. B. Whetsel).

crania would seem to indicate; or whether they were the last remnants of the once powerful nation that erected Fort Ancient and other gigantic works in this region—these and similar queries remain as yet unanswered. More extended investigations and a careful comparison of large amounts of material from this and other localities may be expected to assist in the solution of these obscure but interesting questions.

THE GRAPES OF CALIFORNIA.

ABOUT a year ago the Legislature of California, passed a law "for the promotion of the viticultural industries of the State." A board of viticultural commissioners was organized under the law in June, Mr. Arpad Haraszthy being elected president. From the first annual report of this board of commissioners, the San Francisco *Bulletin* gleans the following valuable and interesting information: The growth of vine culture in California has been without system or technical knowledge of the different varieties of grapevines of their special value in the production of special products. In different localities the same grape has been known by different names, and the industry has been carried on in a haphazard way. In making known to all interested what has been discovered or learned by practice in establishing an experimental vineyard containing specimens of all varieties of grapes grown in the State, and creating a systematic nomenclature and in disseminating information as to ways in which the ravages of the phylloxera and other dangerous insects may be checked, lies the chief value of the work of the State commission. The board discovered that the phylloxera, which was supposed to exist only in the county of Sonoma, existed also in Napes, Solano, Yolo, El Dorado, and Placer counties. The urgency of united action to check the ravages of this insect is shown by the fact that 150,000,000 acres of vineyards in France have been destroyed by it, and that during 18~0 the importations of wine into France were over 100,000,000 gallons an amount which far exceeded the total exports. The California vintage of 1880 is estimated as follows:

9,500,000 gallons dry wines at 25c	$2,375,000
700,000 gallons sweet wines at 60c	420,000
450,000 gallons brandy at $1.15	517,500
Raisins	100,000
Table grapes	187,500
Total	$2,500,000

This represents over 55,000,000 pounds of grapes. Over 10,000 acres were planted in new vineyards during 1880, and 20,000 will be planted this year. Good grape lands can be obtained anywhere in the State at from $10 to $150 an acre. "A vineyard can be planted and maintained until its first year of production," says the president, "for $75 per acre, and the net yield to the producer in coin this year has not been less than $50, and the greater number have reached $100 per acre." Grapes sold last year at from $ 5 to $80 per ton, and the product varied from three to thir-

teen tons per acre, the cost of production being about $20 per acre. The vineyards are along the coast, upon the foothills of the Sierras, in the broad valley that forms the central part of the State and on the mountain sides to the east. The native California vine called the "Mission" is a different species from the varieties grown in Europe. The California vine is hardier than the European, and the wine it produces is not very palatable. Cuttings, grafts, and seeds were on this account obtained from Missouri, Ohio, and Europe as early as 1858. The Mission grape, however, continues to be cultivated more than all other varieties, and to secure the best product from its culture the practice of "blending" it with finer varieties grew up. In San Francisco alone last year 250,000 gallons of wine were manufactured. Professor E. W. Hilgard says: "Judicious blending has become the height of the art of wine-making, for it certainly is an art, and a difficult one, to produce the best result from materials so infinitely varied, even as regards the same grape variety in different seasons. So far the blending has been chiefly in the hands of the wine merchants of San Francisco. It is no reflection upon these gentlemen to say that they have not been altogether successful in their efforts to adapt the uncertain raw wines that come to their cellars to the established tastes of the world's market. It stands greatly to their credit that on the whole neutral spirits, logwood, glycerine, and sulphuric acid have played but a small role in their manipulations, and that the character of California wines for purity—that is, for containing only the juice of the grape—has not suffered at their hands."

Commissioner C. A. Wetmore mentions nine species of American vines, the Rupestris, Cordifolia, Riparia, Arizonica, Californica, Æstivalis, Candicans, Labrusca, and Vulpina. Of these there are over one hundred varieties. These stocks are cultivated as substitutes for the European vines or as grafting stock for more esteemed varieties. The Californica flourishes everywhere, and may be grown from the seed with the greatest ease, but cuttings take root slowly and with difficulty. Seedling roots are most valuable for grafting stock. Pieces of the canes of cultivated vines have been very successfully grafted to pieces of the root of the wild vines, the first year's growth being from ten to fourteen feet. The growth of the Arizonica for brandy-making is destined to be very profitable, as the alcoholic yield of its grape surpassed that of the vines of the cognac district in France.

The report of the sub-committee on Phylloxera is of historical as well as practical value. Satisfactory evidence was found that this pest made its appearance very soon after the first vines were imported from France in 1858. This is exactly the time at which, as the French charge, the phylloxera was brought into France from America. That its devastations have not been so fatal in California as in France and Spain is believed to be due to the fact that the American species, which still form nine-tenths of the stock, are hardier than the European varieties of the Asiatic species, which have been weakened by high cultivation. The phylloxera has done the most injury among plants on shallow soil or on cold, clayey, adobe bottoms. The remedies proposed are the planting of vines on sandy soil, the submersion of vineyards for a season each year, the use of bisulphide of carbon as an insecticide, with potash fertilizers and the exclusive use of resistant American vines for grafting stock. A law is recommended to prevent the importation of vines which have not been inspected and disinfected by a State officer.

California is best supplied with varieties of Rhine wines, of which there are known selections for judicious blending. The best white wines are the Reislings, Golden Chasselas, Blane Elba, Tramaner, and Burger. There is a notable deficiency in clarets, the Zinfandel, of which Californians are very proud, which generally passes for claret, being a Hungarian and not a French stock. Wines approaching the Bordeaux can best be grown in Napa and Sonoma. There are no Burgundy plantations, although heavy clarets pass as such. Napa and Sonoma counties produce the best German varieties, and Zinfandel and Santa Clara the best French varieties. There are no plantations of true sherry grapes. The nearest approach to a sherry grape is the Mission. The seedless Sultana or "Wine of Soudan" grape, which is a native of Africa and can be easily acclimated, is spoken of as destined to become a leading wine as well as raisin grape. The practice of "treating" in wine cellars is strongly protested against. The question of temperance is discussed from a French standpoint. It is claimed that the percentages of disease and crime attributable to alcoholic excesses decrease in proportion as the consumption of wine and beer increases; that fermented drinks exert a different effect upon the system than distilled spirits of the same alcoholic strength, and that natural wine and beer cure the thirst for spirits. Mr. Wetmore adds: "The distinction between 'hot' and 'cold' wines should be made as soon as possible; the former, of which the 'Mission' is an example, should not be encouraged as habitual beverages, and the grapes that produce them should be diverted to the production of liqueur wines and brandies rather than imitations of clarets, hocks, and Sauternes. No wine that requires alcohol to keep it should be tolerated as a table drink. The distilleries afford ample outlet for such productions." At hotels and restaurants California wines are generally served under French labels. "Wine drinkers who wish to avoid cocktails as appetizers and punches as digesters have good reason," says the report, "to complain of any hotel in California which does not treat them as fairly as tea and coffee drinkers, as a pint of wine costs no more than a cup of tea or coffee."

A chapter is devoted to the raisin-making industry. It is only within the last few years that a marketable raisin has been produced. In 1879 75,000 boxes were produced. The product of the State is now greater than the consumption, and no raisins are imported to the State. The California product is yearly improving in quality, and there is every reason to believe that a large export trade to the Eastern States will grow up in a few years.

There are still many things standing in the way of rapid improvement of quality in California wines and the development of the industry upon a solid foundation. The higher price of labor is a great disadvantage. The vines, as a rule, are not pruned close enough and are allowed to bear too many bunches. California growers are importing vines from Missouri, Ohio, and Europe; while France, Spain, Portugal, Italy, and Australia are sending in orders for California vines. There is a great dearth of experts in viticulture and the manufacture of wine. Too little attention is paid to fertilizers. The bone-meal factories of San Francisco send all their products to New Zealand and Australia. Yet in a few years it is predicted the wine product of California will exceed 100,000,000 gallons. The State is the only one where the European varieties can be successfully grown. The State now consumes herself three-fourths as much as is imported into the United States from all foreign countries, and exports to the Atlantic States more than the whole country imports from France. As Commissioner Rose says: "The possibilities here are immense. A great future is in store for us, if it is a fact, and I believe it, namely, that Europe will buy our wines."

BUTTER AND BUTTER-MAKING.*

DR. E. L. STURTEVANT, of Framingham, was the first speaker. He commenced with the axiom: Milk was the basis of butter-making. One parcel of milk, he said, would make butter, while another would not, showing great difference in its characteristics. The quality of milk may be influenced by the feed given to the cows. He would treat of these animals as butter cattle, stock cattle, and store cattle, confining his remarks at present to the former. He raised four tons of corn stover to the acre, equal in feeding value to six-tenths the weight of good hay. Good butter cannot be made from the milk of cows fed entirely on corn stover; in fact, milk is deteriorated to the extent of stover thus fed. Corn-meal does not increase the flow of milk, only so far as its nutritive value extends. Cotton-seed meal increases the flow of milk. Give a cow all the good hay she will eat, and the addition of corn-meal will not increase the flow of milk.

A milk yielding eight per cent. of cream will often give more butter than one yielding sixty per cent. The constituents of milk can best be illustrated by the use of the microscope in comparing the clusters of butter-globules therein contained. Through this test the Jerseys were proved emphatically to be the butter cows, the largest butter-globules always producing the most and best butter. Where cream rises rapidly, leaving a blue skim-milk, then the cream is best. When skim-milk looks of a whitish color, smallness of globules is indicated, and an imperfect separation from the milk. The length of time consumed in churning is determined largely by the size of the butter-globules, the largest specimens giving the quickest results in the churn.

Any food that is acid is bad for butter-making. Feeding corn stover reduces the size of the butter-globules, while corn-meal tends to increase their size, and hence is best for butter. Shorts are the poorest feed known in butter-making, reducing the size of the globules. Cotton-seed meal conveys a bad taste to butter, reducing the market value of the product. Linseed-meal occasions no injury, while cotton-seed does, when fed to excess. Cob-meal from Eastern corn is as valuable for feeding cows as Western corn-meal, pound for pound. One characteristic of linseed-meal was to avert disease, and should be fed to cows two weeks before dropping their calves. The admixture of different parcels of milk reduces the butter product, as the size of the butter-globules is changed, or, rather, different sizes are combined, the largest coming first, while the smaller, remaining unbroken, simply serve to enrich the buttermilk. Two quarts of cotton-seed or of linseed daily is a large feed for a cow, three pints being a safer quantity to feed.

The next speaker was E. F. Bowditch, of Framingham. In his opinion, in the matter of butter-making, cleanliness should come before godliness. Good feed is the basis of good butter; included in the former are good early-cut hay, rowen, carrots, and corn-meal. He grinds his Indian corn cobs with the corn, and considers it as good as Western corn-meal, pound for pound. Cows should be kept scrupulously neat and clean—the same should apply to the stable.

He is not in favor of barn cellars, because the odors from the manure permeate the hay, thus finally injuring the quality of the butter. He practices deep setting with the milk, but is not particular about the method of setting, provided other conditions are right and the milk and cream removed from the deleterious effect of bad odors. Perfectly sweet cream will not make as good butter as cream which is allowed to ripen before churning. The lactic acid begins to form in sweet-cream butter, soon making the butter rancid. Ripen the cream until it tastes a little acid.

The proper temperature for the cream, in winter, for churning, is 62°, in summer 55°. To ripen his cream in winter, he sets his cream-tank in a tub of warm water, stirring the cream with a paddle until it is brought to a temperature of 100° or thereabouts; then by setting it in a warm room until the acid is developed slightly before the churning process is commenced. An oscillating churn is used. When the butter comes, and is the size of kernels of corn, the buttermilk is drawn off; next the butter is washed with iced brine until the buttermilk is pretty well washed out.

He uses a butter-worker, never allowing the butter to be touched with human hands. Finally, to get out all the moisture, he uses large sponges, with which he rolls up the butter after having been rolled out in the worker, continually mopping the flattened butter. The sponges are kept in ice-water. He rolls the butter out three or four times, according to judgment; uses half an ounce of salt to the pound of butter; keeps the product covered, to prevent the escape of the aroma into the air; churns the cream one day, putting the butter product into balls or lumps the next day, usually making half-pound lumps. His butter retails in Boston at eighty cents per pound.

Jersey and Guernsey dairy cows are kept in about equal numbers; turns his cows out to grass in the summer season; takes two weeks in effecting, in a gradual way, the complete change from hay to grass; feeds his cows what they need before watering; experimented by feeding one cow with eight quarts of shorts per week, being obliged, in consequence, to discount on her butter product when it reached the market. Good butter cannot be obtained if cows are fed with shorts. He cuts his hay in June; allows his milk to stand twenty-four hours to raise the cream; and thinks the system of deep setting gives him increased quantity of butter.

Mr. Bowditch continued by stating that Franklin County usually sends 838,000 pounds of butter to Boston market. An increase in price of 10 cents per pound would make an extra profit of $80,000 to this county alone. The average price of Franklin County butter was but 25 cents per pound; a single county in Vermont sends butter to Boston that averages 40 cents per pound; choice Western creamery butter commands 37 cents per pound. Making butter at 25 cents a pound is not a profitable business, and there is no necessity for selling fine butter at that price.

In answer to a query why the human hand injured the butter, the speaker remarked that there are innumerable pores in the skin, which throw off the wastes of the system. The cleaner the hand, the less the obstruction to this process and the easier the refuse matter of the body, or the insensible perspirations, was disposed of. All such matters injuriously affect the purity of the butter, to say nothing of the ill effects of the heat contained in the hand as applied to butter.

Joseph S. Wells, of the Hatfield Creamery Company, was the next speaker. In starting the Hatfield, Mr. Wells stated that the managers had to contend with a sad lack of system in caring for the cows, as well as the admixture of milk from all the different breeds of cows. Care and cleanliness have much to do with successful results in butter-making. During the temporary sickness of their butter-maker, the managers churned three times, succeeding in good results twice and failing once. In the latter instance, when the butter should have come in forty minutes, a failure resulted after two and one-half hours' churning.

Mr. Wells does not agree with Dr. Sturtevant's statements relative to the difference in cream. One quart of cream raised under similar conditions, whether from one cow or another, will make equal quantities of butter. Our cream is allowed to ripen until it tastes slightly sour before churning. The sales of our butter have netted us 30½ cents per pound. We use the system of deep setting for all our milk. It takes a longer time to churn from deep settings than from shallow settings. We have patrons whose cows yield, to seven quarts of milk, one pound of butter. In November the average record was one pound of butter from every ten quarts of milk.

In conclusion, Henry E. Alvord made some brief remarks upon the proper method of judging of the quality of butter as exhibited at our fairs. Often it is the case that the reputation or popularity of the individual who owned the butter drew the premium, instead of the excellence of the butter product on exhibition. He wished for the adoption of a system of marking for flavor, grain, color, salting, and style, say on a scale of one hundred points, a plan which the managers of our coming fall fairs might do well to consider and carry into execution.—*Amer. Cultivator.*

* Abstract of addresses at a meeting of the Franklin County Institute, held at Greenfield, Mass., March 19, 1881.

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PATENTS.

In connection with the **Scientific American,** Messrs. MUNN & CO. are Solicitors of American and Foreign Patents, have had 35 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & CO.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 37 Park Row, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.